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ARCHITECTURE FOR AN ORDER ORIENTED DISTRIBUTED PRODUCTION SYSTEM: INTEROPERABILITY BETWEEN PRODUCTION PLANNING AND CONTROL AND INDUSTRIAL AUTOMATION

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ABSTRAC

Manufacturing companies suffering constant pressure from the market, in a scene of mass customization in large scale, are obliged to become agile and flexible. In last decade appeared several proposals of distributed architectures of production to addresses the market requirements. These proposals are mainly based on the following paradigms: Bionic Manufacturing System, Holonic Manufacturing System and Fractal Factory. These paradigms have some common characteristics; they are essentially distributed system composed by distributed cooperative and autonomy units. The concept is adherent to the concept of agents or multi-agent system. This document will approach multi-agent system, the application of multi-agent technology in production and resource allocation dynamically, and the interface of this architecture with machines.

INTRODUCTION

The production systems managers have new challengers due not just high complexity of processes and products, but also the increase variety of these products that should be put in the market in less time (the lifecycle is shorter). Additionally, the companies, in an environment of free concurrence, are looking new and modern methods to become more agile and flexible, totally adaptable to changes.

The tendency to product personalization implies in improve consistently the integration between the industries and the consumers. In the last years a set of architectures for production systems appeared that answer to these requirements, and they are based on distributed units of production, cooperative and autonomous. These proposal architectures are normally adherent in these three paradigms (Tharumarajah et al. (1996)), nominated: BMS - Bionic Manufacturing System; Holonic production systems; Fractal factory systems (Warnecke (1993)). These paradigms have coincident concepts characterized by distributed and autonomous units that can cooperate and manage production processes. Then, a potential structure for a distributed production system is composed by a conglomerate of autonomous units that operate in cooperation.

The main objective of this research project is to propose an distributed production architecture, based on the multi-agent paradigm, that should be able to: address each customer order as unique; interoperate production management processes with industrial automation control.

DISTRIBUTED PRODUCTION SYSTEM

For Fletcher (2002) the increasing complexity of the production systems and the search for production process more flexible has stimulated the development of decentralized control system like the holonic multiagent systems. The holonic multiagent production systems are based on productive units, called holons, that are part of a holarchy called organization. This holons can be composited by other holons (subsystems), and then they can form a production system. Each holon has characteristics of something that is simultaneously a whole and a part of the functionality of the system.

Van Brussel et al. (1998) presented the most cited reference of architectures (PROSA) of the holonic multiagent production systems, based on “product”, “order” and “resource” holons.

The distributed production systems have been created to propitiate efficiency and rationality in the process of distribute the use of production resource, in order to provide dynamic and fast manufacture. The production units must have capacity to be intelligently and efficiently reactive in case of not predictable changes in the external environment, keeping the production controlled and continuous.

Considering the necessity of a planning and control system that can be adaptable to use local and distributed resources and materials, it is mandatory the creation of a generic model generic to permits the selection, the allocation and the operation of the production resources, to accelerate planning process. This model can be the base to construct a system based on agents. A multiagent system can still support the experimentation and the study of the dynamic characteristics of the distributed model of the production planning and control.

THE PROPOSED ARCHITECTURE

A possible model could assume that agents "resource" have knowledge of the resource capability. Considering the transformation knowledge, the agent can get production orders through a negotiation process using Contract Net Protocol with others agents, within a multiagent distributed system.

The information regarding to the availability and the specialty of the resources is can be valuable to the multiagent system. With the vision of the capacity and the availability of each productive unit, the system is capable to send and to control production orders. The resources selection to satisfy the demand in distributed systems of production is one of the problems presented in Tharumarajah (2001).

In previous works presented by Lima (2003) and Lima et al. (2006) it is possible to verify the interest in order oriented distributed production systems using multiagent technology.

The dynamic interaction between production planning and automation equipment comes being studied for some authors using models based on the paradigm of software agents. Yanli et al. (2006) describe a multiagent system to manage activities or production orders received from ERP/MRP system.

In the architecture proposed the resource agents, that personify particular machines like surface mount technology machines, interacts with client agents, that personify the production planning and control, to negotiate production orders. The architecture should coexist with the industrial network environment.

INDUSTRIAL CASE STUDY

This proposed architecture is being developed in a company that mounts personal computers boards and notebooks. This company has several production lines divided in stages: SMT assembly, manual assembly and tests. Some lines work in three working hours. Such characteristics, adding the usual external changes, make the scenario propitious environment to apply the proposed model.

CONCLUSION AND FUTURE WORK

The proposed architecture, based on multiagent technology, has the challenge to provide the interoperability between production planning and control and machines.

The system development is in the phase of specification, and prototypes, and it was identified two new requirements: the system should provide a consolidated BOM (Bill of Material) and the system should generate operation instructions (operators and employees).

REFERENCES

Fletcher, M., 2002. Holonic Manufacturing Systems: Some Scenarios and Issues, Mill Lane, Cambridge, CB2 1RX, United Kingdom, Agent Oriented Software Ltd.

Lima, R. M., 2003. Sistemas distribuídos de produção em ambiente de produção simultânea (portuguese). Tese de Doutoramento (PhD). Escola de Engenharia, Universidade do Minho: 250.

Lima, R. M. and Sousa, R. M., 2007. Agent Based Prototype for Interoperation of Production Planning and Control and Manufacturing Automation, in 12th IEEE Conference on Emerging Technologies and Factory Automation, Patras, Greece.

Lima, R. M., Sousa, R. M. and Martins, P. J., 2006. "Distributed production planning and control agent-based system." International Journal of Production Research, 44(18 - 19): 3693-3709.

Tharumarajah, A., 2001. "Survey of resource allocation methods for distributed manufacturing systems." Production Planning & Control, 12(1): 58-68.

Tharumarajah, A., Wells, A. J. and Nemes, L., 1996. "Comparison of the Bionic, Fractal and Holonic Manufacturing System Concepts." International Journal of Computer Integrated Manufacturing, 9(3):217-226.

Van Brussel, H., Wyns, J., Valckenaers, P., Bongaerts, L. and Peeters, P., 1998. "Reference architecture for holonic manufacturing systems: PROSA." Computers in Industry, 37(3): 255-274.

Warnecke, H. J., 1993. The Fractal Company, Springer-Verlag.

Yanli, H., Haicheng, Y., Weiping, H., Wei, Z. and Xinping, H., 2006. Flexible Workflow Driven Job Shop Manufacturing Execution and Automation Based on Multi Agent System, in Intelligent Agent Technology, 2006. IAT '06, 695-699.