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REMOTE CONTROLLING FUNCTIONALITY IN UBIQUITOUS MANUFACTURING SYSTEM - CONTRIBUTION TO AUTOMATIC SYNTHESIS OF FORMAL THEORIES OF PRODUCTION SYSTEMS AND VIRTUAL ENTERPRISES

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Formal Theories, Ubiquitous Manufacturing System,
Remote CNC.

ABSTRACT

The first principal objective of the project is validation of two scientific theses concerning the problem of automatic synthesis and use of Formal Theory (FT) of Production Systems and Virtual Enterprises (PS/VE):

- 1 It is possible to automatically generate a valid FT for PS/VE systems and subsystems; and
- 2 FT provides more efficient design process than usual intuitive “ad-hoc,” informal or only formalized design solutions.

These theses will be validated through evaluation of the design process and outputs (solutions) of the traditional design processes in comparison with the specifications obtained by the automatically generated FT (of the corresponding real-life PS/VE).

In order to achieve these objectives, an embedded software tool, a demonstrator, is developed to be used as a physical networked system of manufacturing cells, for testing of the FT generated for the above theses.

STATE-OF-THE-ART AND OBJECTIVES

Concerning the “state-of-the-art” of the development of a FT of PS/VE, there is no consistent and rigorous approach towards the FT of PS/VE, except the initial results in the FCT Interdisciplinary Centre of Production Technologies and Energy (CITEPE) at the University of Minho, through one PhD project (Sousa 2003) and one MSc project (Rosas 2000), and a number of papers, (Putnik and Sousa 2006) and (Sousa and Putnik 2004).

The objective of the project, which is the automatic synthesis of FT, will be limited to relatively smaller systems that in reality represent the “real-life”

production systems, or VE, subsystems or some specific aspects, e.g. manufacturing cells and FMS (Flexible Manufacturing Systems) as a “real-life” production systems subsystems, and their functional and physical structures and specific aspects (e.g. spatial structures, processes structures, control and organizational structures, VE organizational structures, and similar). It is important to mention that the Formal Grammars and Abstract Automata (FG/AA) are a FT rigorous models (Minsky 1967), which is a strong base for the proposed PhD project, as the FG/AA theory is a well formed and validated theory (in computer science).

Finally, this project represents continuation of the fundamental research on the topic in the FCT Interdisciplinary Centre for Production Technologies and Energy – CITEPE, UMinho.

METHODOLOGY

As a physical testbed system, a prototype demonstrator of Ubiquitous Manufacturing System (UMS) is developed, with functionalities of a typical manufacturing cell with CNC machines and network communication among several such cells and distant users, thus forming building blocks for creation, and basis for validation, of another demonstrator of Automatic Synthesis of Formal Theories of PS/VE.

Thus the above theses will be validated through an analysis of consistency of the “real-life” cases and specification(s) by the automatically generated FT (of the corresponding manufacturing cell, or FMS, class).

UBIQUITOUS MANUFACTURING SYSTEMS

The UMS demonstrator goals are discussed in (Putnik et al. 2008). The overall architecture of the UMS demonstrator is based on a structural hierarchical – client-server – model. But to improve this hierarchical



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model, a third intermediate level was included, between client and server (resource) levels, for reconfiguration mechanism. The intermediate level is called broker / resource manager / mediator. Another fundamental role of the intermediate level, i.e. the broker, is to be the level that provides virtuality.

The architecture is based on the BM_VEARM (BM_Virtual Enterprise Architecture Reference Model) (Putnik 2001).

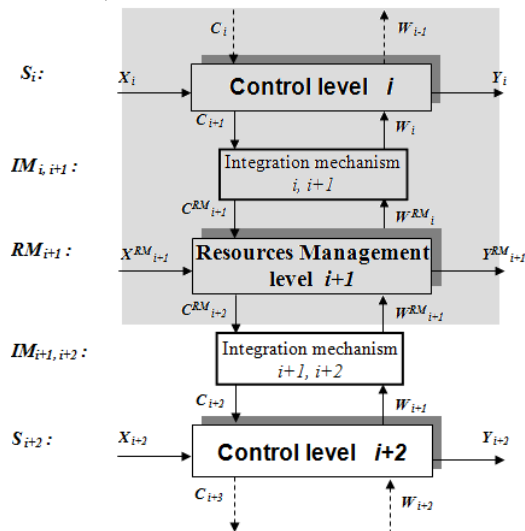


Figure 1: BM_VEARM elementary structure, or structural pattern (Putnik 2001); the client plays role of “resource manager” also.

In order to connect these three-layers an Internet communication protocol is used, in order to provide geographically independent communication, i.e. remote client-server communication, or remote control of MS equipment.

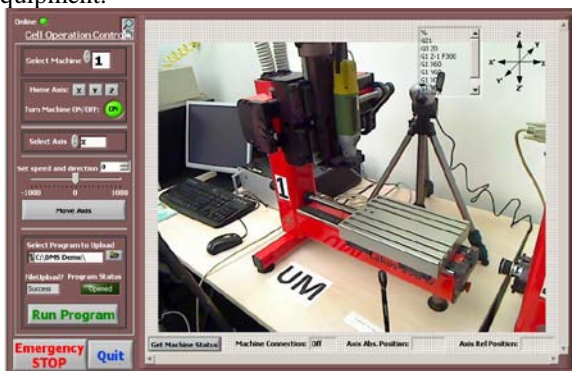


Figure 2: Client screen operating on remote machine. Remote controlling functionality in the UMS demonstrator

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