Proposition of a generic model for the control of a guided flow system / Application of the holonic concepts in intelligent transportation (FMS/PRT)

Abstract

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The thesis is structured in six chapters completed by a conclusion and one annex.

The first chapter makes a brief description of the guided flow systems based on two types of systems: flexible manufacturing systems (FMS, Groover, 1987; Leitão, 2004) and personal rapid transportation / transit (PRT, Carnegie et al., 2007). The aspect of controlling a guided flow system is treated next, with its two main parts: resource allocation and routing. For these problems, the classical theoretical solutions (centralized, hierarchical, heterarchical and semi heterarchical control) as well as the concepts needed to implement them (multi-agent systems, holonic manufacturing systems and "open ontrol" concept) are presented. The chapter concludes with the justification for choosing a non centralized and open control architecture, inspired from the holonic concepts through the introduction of active holon entities.

The second chapter describes the composition of the active entity system (AES) and the holonic model associated the AES. This generic control model characterized by active and non active flows of entities is then presented with its two components: the structural model, which defines the components of the system, their characteristics, internal and external interactions, and the behavioral model consisting of process planning, resource scheduling and routing, which are based on the open-control concept. The proposed generic control model is based on the dialogue between the active entities and on the dynamical routing process which uses online information measured by the active entities.

The third chapter presents the adaptation of the generic control model to the special requirements of a discrete and repetitive FMS which disposes of an automated transportation system (conveyor) connecting the workstations. The main characteristics of the fabrication cell CIMR form the University Politehnica of Bucharest are described and then the holonic control model is detailed with a particular focus on the Resource Service Access Model, on the tracking of production orders and resource status and on the steps needed to cope with the change of resource status in order to assure fault tolerance.

The fourth chapter describes the physical infrastructure of the CIMR fabrication cell where the model proposed in chapter two with the adaptations proposed in chapter three has been implemented. The qualitative and quantitative tests are performed on this implementation to test different planning and allocation scenarios. This chapter ends with an analysis of the system behavior in case of perturbation (e.g.: resource failure) which justifies a decentralized control architecture exploiting the decisional capacities of the entities.

The fifth chapter presents the adaptation of the generic control model to the special requirements of a dedicated transportation system (PRT). First, the essential components (vehicles, stations, infrastructure, etc.) and functioning principles of such a system are presented. Then, the adapted structural model and the dedicated behavioral model, based on the implicit control, are presented. Each PRT decides its own route by the aid of a routing map of the system updated in real-time.

The sixth chapter describes the experiments that had been done at the AIP-PRIMECA site at the University of Valenciennes utilizing the control model described in chapter five. After presenting the physical infrastructure of the cell the protocol for experimentation is described. It consists of three scenarios showing the scalability, adaptability and the capacity of the system to be influenced by an upper control layer.