Cooperative Decision-Making with Scheduler Agents

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Abstract. In this study, an Agent-Based Collaborative Scheduling System is represented as a model of scheduling among shops. Agent-based system describes the behaviors of distributed decision maker agents in manufacturing systems. Agents in the system are Production Planning Agent and Shop-Floor Agents. Shop-Floor Agents are semi-autonomous agents so that the degree of autonomy is determined by the Production Planning Agent. The distributed system forming heterogeneous units was designed by hybrid control architecture. The study focuses on constructing an Agent-Based Collaborative Scheduling System that is capable of conducting scheduling negotiations among shop-floor agents. The designed system is capable of scheduling by considering heterogeneous objectives of the shop-floor agents within a collaborative manufacturing environment. Negotiation is co-operative not competitive. Shop-Floor Agents generates collaboratively their schedules. The schedule for the best interest of the system as a whole is selected by the Production Planning Agent.

Keywords: Agent-Based Production Systems, Collaborative Scheduling, Cooperative Decision-Making.

1 Introduction

Manufacturing system control entails the coordination of a large number of physical activities and information processing activities related to the entities on the shop-floor to achieve desired production goals. In the last decade manufacturing research started to study potential applications of agent theory to production systems. According to this theory decision making process is distributed among intelligent and autonomous agents. The overall objective, in fact, is split into many local one. And agents act to reach local objectives. The approach allows overcoming the problems of complexity such as large volume data, production capacity distributed among resources [1].

Advances in Computer and Communication Technologies now make it possible to provide manufacturing system entities with intelligence and communication capabilities. So the studies on using agent technology in shop-floor control have been increased. This shop-floor control system can be characterized as a collection of intelligent autonomous entities capable of individual decision making on the basis of local information and information obtained through communication with other entities. This alternative control system is gaining increasing levels of attention and acceptance in academia and industry [1].

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A Multi-Agent System (MAS) is an artificial intelligence system composed of a population of autonomous agents that cooperate with each other to reach common goals, while simultaneously pursuing individual objectives [2]. The increasing interest in MAS research is due to the significant characteristics inherent in such systems [3]. According to the writers, these characteristics are as follows:

- Taking initiative to reach certain objectives
- Independent decision-making by individual agent based on its domain knowledge, local and global conditions.
- Perceiving changes in their environment and acting as a consequence.
- Interacting with other agents and humans for effective negotiation, cooperation and coordination.

Most MAS designed for shop-floor control are actually designed for homogeneous systems and apply the assigning rules involving only market-based mechanisms. Studies on heterarchical pattern are more limited and the interest in this subject has increased over the last decade. Agent technology is considered to be a significant approach towards developing industrially distributed systems. Many researchers have applied agent technology to supply chain management systems, manufacturing scheduling and control systems, and material transportation systems. Some of them:

Kadar et al. (1998), surveyed agent-based structures to distributed manufacturing architectures[4]. Maturana et al. (1999), presented an adaptive multi-agent manufacturing system architecture called MetaMorph [5]. Fox and et al. (2000), investigates issues and presents solutions for the construction of such an agent-oriented software architecture [6]. Ottaway and Burns (2000), presented Adaptive Production Control System (APCS) that it has dynamically changing control architecture [7]. Huang and Nof (2000), describes a modelling approach developed to design a manufacturing system as a society of autonomous agents called Autonomous Agent Network [8]. In the paper of Gjerdrum et al. (2001), multi-agent modeling techniques are applied to simulate and control a simple demand-driven supply chain network system, with the manufacturing component being optimized [9]. Maione and Naso (2001), propose an approach to job flow adaptive operational control in advanced manufacturing systems [10]. Agents are implicitly coordinated by a nature-analogous adaptation mechanism. (Lu and Yih, 2001), presented an agent-based collaborative production control framework. It is capable of conducting scheduling and dispatching functions among production entities [11].

Multi-agent systems are designed to decentralize the control of the manufacturing systems, so as to reduce the complexity and to increase the flexibility [12]. This study focused on an Agent-Based Collaborative Scheduling System (ABCSS). The system makes the realization of the scheduling possible by balancing the heterogeneous aims of three shops following each other. The collaborative scheduling system recalls the patterns of pull and push systems. The control architecture is hybrid control which is designed without taking over the central control of production planning unit.

The paper is organized as followed. In section 1, there is an introduction and literature review of paper. Section 2 presents Agent-Based Collaborative Scheduling