Intelligents Agents supporting Digital Factories

Nicola Bicocchi, Giacomo Cabri, Letizia Leonardi, Giulio Salierno

EU H2020 “vF Interoperation supporting business innovation” (FIRST Project Grant No. 734599)
Agenda

• Motivation of the work
• Overview of digital factories in the context of Industry 4.0
• Agent-based architectures for digital factories
• Discussion on pros and cons of agent based methodologies for digital factories
Motivation

• Digital Factory is a key core concept for enabling next generation of factory of the future

• Evaluation of agent methodologies (MAS) to enable key tasks of digital factories
Digital Factory

• A digital factory refers to a new type of manufacturing production organization that simulates, evaluates and optimizes production processes and systems.

• It covers the entire product lifecycle through:
  • Collaborative design based on models
  • Simulations of virtual plant representing the real factory

• Digital Twin model:
  • Create virtual models of physical assets
  • Optimize the production process by simulations
  • Establish a two-way connectivity between the real and the virtual factory
Digital Factory

• In a digital factory the collected data improve virtual models accuracy and simulations
• A digital factory acts as a data management layer

Fujitsu and INESA Group Smart Manufacturing Project for "Made in China 2025"
MAS-enabled digital factory

- Agent-based manufacturing is a highly distributed control paradigm that can cope with challenges of a digital factory.

- Considering life cycle of a digital factory we identified MAS architectures providing digital abstraction of physical factory with a focus on:
  - Vertical Integration
  - Abstraction
  - Human Integration
CASOA: An Architecture for Agent-Based Manufacturing System in the Context of Industry 4.0 (Tang H et al)

- Cloud-based architecture based on agents which cooperate to carry out global manufacturing tasks

- Ontology combined with agents
  - Hierarchical knowledge model used from agents

- Scheduling is optimized compared to traditional methods
Agent-based fault tolerant framework for manufacturing process automation (Zubair H et al)

- Deployment of Agent-Based Fault Tolerant Framework (ABFTF) in a manufacturing process for Fault detection

- Events are gathered from the shop floor and analyzed in order to determine possible disruptions

- The results showed a significant reduction in the process downtime, for different types of disruptions
Potential of a multi-agent system approach for production control in smart factories
(Saeidlou et al)

- MAS architecture for dynamic and adaptive production scheduling
  - Tolerant to changes of the network topology

- Supervisor agents update the coordinator about status of product and machine agents

- Evaluation of 4 real-case scenarios has shown flexibility and ability of the architecture to react to machine breakdown as well as good performances in production scheduling
An agent-based monitoring architecture for plug and produce based manufacturing systems (Rocha AD et al)

- MAS middleware to deal with monitoring at different manufacturing levels
- Knowledge-based system stores unwanted events
- CNP and FIPA protocols for communications and negotiations between agents
Conclusions

Main advantages of software agents in digital factories:

- Autonomy
- Adaptation
- Decentralization
- Robustness

Some limitations:

- Simplicity
- Human integration
- Real-Time
Thank you for your attention!