Multi-agent for manufacturing systems optimization

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Multi-agent for manufacturing systems optimization

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Abstract. The paper is meant to be a dynamic approach to optimize manufacturing systems based on multi-agent systems. Multi-agent systems are semiautonomous decision makers and cooperate to optimize the manufacturing process. Increasing production the capacity is achieved by developing, implementing efficient and effective systems from control based on current manufacturing process. The model multi-agent proposed in this paper is based on communication between agents who, based on their mechanisms drive to autonomous decision making. Methods based on multi-agent programming are applied between flexible manufacturing processes and cooperation with agents. Based on multi-agent technology and architecture of intelligent manufacturing can lead to development of strategies for control and optimization of scheduled production resulting from the simulation.

1. Introduction
Multi-agent systems consist of several systems composed of several interacting elements called agents, [1].

A perspective which can be approach is to implement a architecture that analyze the behavior and according to this analysis deliver an information, this response become an important component in decision making process, [8].

To develop the modeling process are known more tools and concepts, such as: LabVIEW, Petri nets, genetic algorithms. In this paper to develop the modeling process we decided to use Petri nets, because the model is relatively easy to understand, modeling the package is easy to use and diagrams are easy to interpret in order to make the right decisions.

Each modeling tool is equipped with a device that allows mathematical modeling of the real system, [1].

According to the literature this type of agents are capable of flexible autonomous action in order to achieve its objectives. Flexibility is intended to define the properties of reactivity, proactivity and ability. This type of system is a system where agents interact through different mechanisms for achieving individual and collective goals, [3].

We chose to use multi-agent systems because the technology is used successfully in distributed systems modeling. By building distributed applications using multi-agent technology improves system flexibility and their ability to solve urgent and unforeseen situations that may occur within the modeled system.

Increase in production capacity is achieved through the development, implementation of effective and efficient control systems that are based on current manufacturing process, [4].

Using multi-agent systems is a relatively new planning theories based on intelligent multi-agent systems and artificial intelligence.
2. The analysis system
From conceptual point of view, multi-agent systems architecture consists of solving problems between agents and control mechanisms. Agencies act as collaborating to solve the complex problems, [2].

The system architecture must lead to goals and depends on the ability, capability and individual knowledge. The basics are communication, collaboration and coordination.

Thus the coordination of the multi-agent system refers to methods for obtaining an efficient and consistent behavior of the system level.

The main steps in the workflow management involves two phases with individual purpose, namely, planning flows and execution of their. Multi-agent systems are chosen for adequate planning methods. This can be described as an approach to coordination, where early design phase of the sequence of actions that solves a purpose must be taken into account interactions between agents.

In what concerns the analysis of a multi-agent system with high flexibility can be exploited as a basis for future intelligent and automated system is able to control the full chain of production, [3].

Such disclosures can be viewed in a simplified way as a collection of workstations. The role of each station is well established from the outset. Thus according to the activity taking place at the station, it is responsible for assembling (operation) selected. Each station is equipped with a component shops. Each station is seen in this work as an agent with autonomous functions.

Methods based on multi-agent programming can be applied between flexible manufacturing processes and cooperation with agents. Based on multi-agent technology and agent architectures of intelligent manufacturing can lead to the development of strategies to control and optimize production planning, which is obtained from simulations.

The advantages are [5]:
- The communication between agents of the production system is studied;
- Cooperation is completed communication and negotiation;
- During the interaction, the agent role is equipped with flexibility to meet demand for models and build the framework for reusable components;
- It is beneficial to use intelligent manufacturing systems for continuation of further studies.

Multi-agent systems must lead to performing complex tasks. Pillars basic tasks are building a strategy for coordination. Without a good strategy Contracts obtain a chaotic system. Creating strategy coordination in multi-agent systems is based on coordination of activities for each agent. Timing strategy requires real-time processing large volumes of events within the system.

For system modeling with Petri nets is based on the idea that one cannot pass self-sown from a final position to the initial position.

Petri nets are recommended to be used in modeling and simulation because they are easy to understand and allow more precise description of the actual distributed systems can model the specific phenomena discrete event systems. Information from the description of the dynamics of discrete event systems can be implemented relatively easily Petri network architecture type models.

To achieve the objective of this paper is called primarily to analyze and identify the technological process of transportation subsystems, analyzed the SC ROTINA SRL, Hunedoara. Such an analysis makes it possible to define the necessary input data model formulation to be done.

To simulate the transport system should be defined to be simulated model and input data into the system (time, distance and production structure).

The transport system can be assimilated to a discrete event system. These systems form a class of nonlinear dynamical systems using its mathematical tools other than differential equations used in the theory and practice of automatic adjustment.

Description of the system is based on a set that includes events that are arrivals and exits. It is the embodiment of classic transport pallets or palletized synchro monoflux. When transporting pallets, the blank is placed on standard pallets, designed to create special travel facilities, positioning, clamping. If synchronous transport the blank is transported discontinuous and is stable at each processing station during the operation carried out, which favors automatic processing. The model applied to the SC ROTINA SRL, Hunedoara is spread the word of TopCan S.R.L. of Italy, Ricambi.
For this situation we use Petri jumps. [6]. A Petri net $P / T$ with jumps, is a couple $\gamma = (\Sigma, R)$, where $\Sigma$ is a $PTN$, $R$ it is a binary relation on the set of markings $\Sigma$ (i.e. $R \subseteq N \times N$), called the crowd the leaps (self-sown) of his $\gamma$.

If the set $R$ is finite, then it is said that $\gamma$ is a Petri net with finite jumps and otherwise, a Petri net with infinite jumps. A crowd jumps to any network is the most countable.

Therefore a lot is recursive, that can actually decide for any pair of labels $(M, M')$, if $(M, M') \in R$ or not. [6]

Or $\gamma = (\Sigma, R)$ a network with jumps. If the set of jumps $R$ has a finite number of variations ($\Delta R = \{M' - M | (M, M') \in R\}$ it is finite) then it is said that $\gamma$ is a Petri net jumps $\Delta$ – finite. [6]

In this paragraph for timed Petri nets with jumps shaft accessibility is defined analogously to ordinary Petri jumps, adding arcs time information for transitions during which it is associated, so [6]:

1. the root $v_0$ the tree is labeled with the original marking $M_0$ of the network;
2. if $v$ a node of the tree is labeled with a marking $M$, then for any $t \in T$, so that $M[t]$, there is a distinct node $v'$ labeled with $M' = M + \Delta t$, and, for any jump $(M, M') \in R$, there is a distinct node $v''$ labeled with $M'$; in addition there is a spring $(v, v')$ labeled with $(t, \Theta_t)$, if $t$ is timed transition, or with $t$, if $t$ is immediate transition, or with $\gamma''$, if represent a jump.

3. The system architecture
To build a multi-agent architecture must be defined and the roles of each agent which belongs to the system and system interactions.

The system architecture is inspired from a real system applied to SC ROTINA SRL, Hunedoara (Figure 1).

The installation is complete is a complete line of dosing, closing and sterilization canned meat (Figure 2).

The line will be composed mainly the following equipment:
- Discharge system, washing, sterilization and transportation of empty boxes to dosing groups;
- Strips for manual filling;
- Dispenser for pies;
- 4 cans closed machine heads closur;
- Timer dispenser - car closed boxes;
- Conveyor for entry boxes directly in the closed car;
- System supply dispenser;
- Hydraulics for loading;
- Hair Turbo model;
- Electrical installation and control of the line.

Deployment of such equipment is shown in Figure 2, (source: TopCan, Italia, Ricambi, Serial Number 00392).

Conveyor for entry boxes directly in the closed car is analyzed in the paper as coordinating agent for this equipment leads to increased productivity.

Depending on figure 2 was drawn system architecture and simulated model. Working nodes are grouped according to the process. Node 1 is the complex that can be used manually or semi-automatically. Node 2 is automated. Node 3 is the complex semi-automated and should be watched continuously. Coordinating agent examines the entire process through all nodes multi-agent system.
The nodes 1, 2, 3 are independent workstations. The three intelligent agents type detector are positioned in the 3 groups that form the structure ready for diving in Figure 3.

For the simulation work we have grouped the three nodes in Figure 1 in a single process. This activity can be performed both manually and semi-automatically, depending on the requirements. The system then continues with the semi-automatic control system effective control is achieved using a system with touchscreen. The analysis continues with another agent detector system is designed for determining the products reach the markets. This segment of conducts drying, marking and packing boxes to be delivered to retail activity.

Operating good time expressed as a percentage or in units of time, during the storage system functioning normally. Possible causes blockages that may occur in the storage system are: electrical hazards, mechanical, stiff containers, improperly conducted repairs, incorrect procedures used by staff handling.

The model is characterized by the fact that it meets the desirable properties of the object or the system under consideration. Studying given system model can infer new information without having very high costs.

Distributed systems modelling using Petri nets are performed at state level. For this purpose determines what actions occur in the system, which precede these actions and conditions in which states will go after the production system actions. By simulating the model states Petri describing system behaviour is obtained (figure 3).

Petri experienced a rapid development because it benefits from three fundamental strengths: simplicity, generality and adaptability.

The reason is the wide use that has a graphical very accessible and well defined semantics that allows a formal analysis of the behaviour and properties of modelled systems.
Depending on the location of the stations and the transmission relative to the flow of our process consists essentially of the stations in relation to the unilateral transport stream. Stations are not bulky and space proposed processing to optimize the transport system is expanded over a large area (Figure 3).

The proposed network is viable, lined and reversible. These are the characteristics of synthetic step hybrid system.

Analysis of the results obtained by simulation lets you know which countries learned / or system and are not accessible or vulnerable states (Figure 4,5).

Since manufacturing times are very large and difficult process simulation is conducted have divided the graph depending on the transmission system.

**Figure 3.** Systems architecture model.

**Figure 4.** The linear flow for highlighting of the conveyor activity

**Figure 5.** The work flow for evidence for intelligent agent detector

4. Conclusions

Using analysis of events in the multi-agent systems, real-time processing of large volumes of events, special situations can be detected in the system.
The proposed system detects any constraints that may occur in the system and lead to the decision process modeling agents. The advantages of this approach are the possibility to solve optimization and flexibility in modeling and control.

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