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ANALYSIS OF MANUFACTURING SYSTEMS MODELLING BY PETRI NETS

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Abstract. This paper presents a method for the modelling of the manufacturing system. This method uses the Generalised Object Oriented Petri Nets for the modelling of the manufacturing systems. This allows analysing the performances of the manufacturing system, which allow setting the variation domain of the control parameters and lastly the optimal control of the system.

1.Introduction

The high degree of complexity is due to the numerous interactions between the manufacturing system components, which are: competition, synchronizing, resource partitioning. When a new product is introduced for manufacturing, the system experiences conflicts between components, blockages as well as some uncertainties as regards the system functioning.

Automating the manufacturing system does not solve the problems that occur. In order to use the manufacturing system efficiently, we must understand the phenomena that occur in the system and decide upon a suitable coordination strategy for the entire system.

When analyzing manufacturing systems, one of the problems is to describe the phenomena that may occur and namely: breaking down and overhauling of machines, processing times variation.

A manufacturing system can be simulated by using a specific computer software, which, based on a manufacturing system model elaborates a variation of the model parameters, obtaining an image of system behaviour in different circumstances. The disadvantage of simulation lies in that it does not allow obtaining exact results and it takes a lot of time.

Deductive methods are analytical methods used in the analysis of a fabrication system. They allow finding a quick solution to the fast coordination problem of the manufacturing system by using an algorithm-based reasoning. In this category of methods we can include pending queues and Petri nets.

2.Analysis of the Software Visual Object Net++

Visual Object Net++ is a CAD/CAE instrument that allows for model implementation with Petri nets with continuous, discrete and combined events.

This software provides the programmer with the advantages of an easy design, a fast simulation and a simple documentation. It gives the possibility to model and simulate by using elements that are characteristic to Petri nets position-transition, generalised, and temporised with infinite capacities.

Visual Object Net++ is a quick, simple and intuitive utilitarian used for the design, simulation and assessment of discrete, continuous and hybrid Petri nets. It offers animation facilities for an easier observation of the dynamic behaviour of nets. The object oriented user interface allows for an easy design, simulation, visualisation and documentation. In the case of continuous transitions, the execution is continuous. The execution speed can be described by differential equations attributed to transitions. Continuous dynamic systems can be modelled this way.

3.Manufacturing System Modelling by Using Petri Nets

A Petri net is a graphic model of the oriented graph type, with two categories of nodes: places and transitions. The relations between the events that may take place and the conditions necessary for the production of certain events are represented by the graph arcs, which establish connections oriented between places and transitions, and between transitions and places as well, as the occurrence of an event changes the conditions that results from occurrence of the event.

The advantages of using Petri nets in manufacturing system modelling and analysis are:

- Explicit relations between events. The events that are not interconnected are concurrent and parallel.
- The same modelling language can serve to describe the system on different abstraction levels.
- System properties analysis for the solution validation.

4.Manufacturing System Analysis

A manufacturing system is characterised by a multitude of technological variables; that is why using a computer programme for system modelling is necessary.

The analytical model of a manufacturing system must take into account:

- The general system performances,
- The process balance equations,
- Transportation subsystem modelling,
- The machine break-down possibility,
- The number of necessary machines.

The subsystems that form the system under consideration are as follows:

- The control subsystem materialised on a PC named a Cell Controller. It indirectly accesses, by means of interface computers, the control equipment of the manufacturing cell components (robot, processing centre, transfer device).
- The manipulation subsystem contains an industrial robot. The robot's role is to make sure that a semi-finished product is processed from the transfer device and placed in the work device of the processing centre. After it finishes processing, the robot takes the piece from the work device of the processing centre and places it on a specific location on the transfer device. The computer connects the robot controller to the LAN network.
- The processing subsystem is made of the processing centre connected to the cell controller by means of a computer. The processing centre has a tool warehouse and the work device is placed on the machine table, where the semi-finished product is oriented and fixed during processing.
- The transfer subsystem contains the transfer device and processed pieces. The transfer device has indexed movements with the possibility to position a robot post for loading/unloading the semi-finished product/piece into/from the work device of the processing centre. The control equipment of the transfer device is connected to the cell controller through a personal computer connected to the control equipment.
- The storing system is made of a storage room in Cartesian coordinates, structured on rows and columns, where the processed semi-finished products and pieces can be stored.

5.Conclusions

The Petri nets model of the manufacturing cell presented in figure 1 and 2 highlights the components' means of functioning considering the mutual reconditionings that appear in the dynamics of sequence unfolding during the manufacturing process.

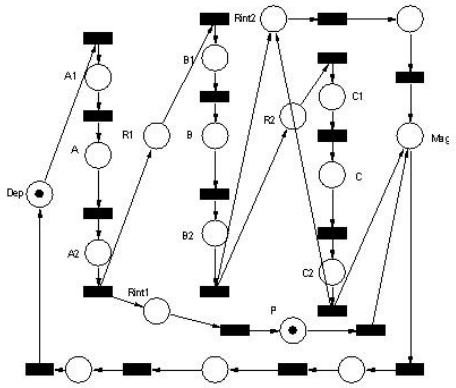

Figure 1: Petri Nets Model

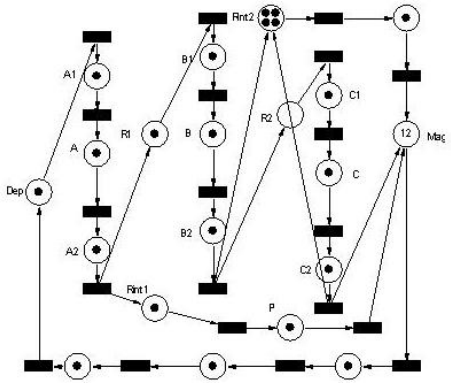

Figure 2: Suggested Petri Nets Model

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