Overview of Modelling Of Production (FMS/CIM) System Using Petri Nets

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Abstract

FMS system using an ordinary Petri Net simulation, modelling and analysis has been in practice in industries for long time. The better understanding of the controlled scheduling. This paper reviews the research work on Petri nets representations Scheduling using PN and PN based scheduling of flexible manufacturing systems. Rule-based PN. We study the concept of Petri Nets and applications of Petri nets. Benefits of Petri Nets in production (FMS/CIM).

Introduction

A Petri Nets (PN) is a graphical and mathematical modelling tool applicable to many for systems. They are a promising tool for describing and studying information processing system that are characterized as be synchronization, concurrency, sequentiality and conflict. As a graphical tool, Petri nets can be used as a visual-communication aid similar to flow charts, block diagrams, and networks. In addition, tokens are used in these nets to simulate the dynamic and concurrent activities of systems. As a mathematical tool, It is possible to set up state equations, and other mathematical models governing the behaviour of systems. Petri net is also known as a place/transition net or P/T net is one of several mathematical modelling languages for the description of distributed system. PN is a directed bipartite graph in which the nodes present transitions (i.e. events that may occur, signified by bars) and places (i.e. conditions, signified by circles).
A powerful and important feature of properties of the system, such as deadlock-freeness and boundness.

Role of Petri Nets

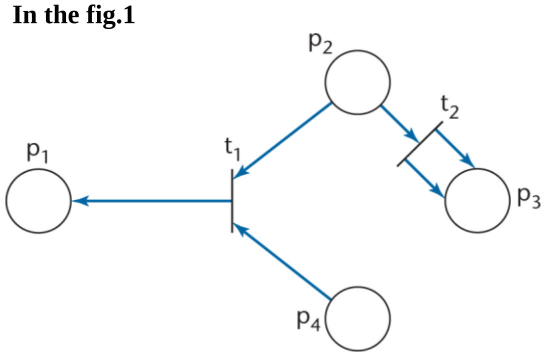
Increase the modeling power of Petri Nets: High level adaptive routing is almost impossible to be modeled using Petri Nets. The addition of rules, functions, events and state change handlers gives the Petri Net model a routine aspect that makes the models more sensible.
Simplify and improve the modeling process: Models can be constructing more easily because of the power of the modeling mold leading to a reduced modeling time.
Improve the scheduling routine: Rule-base terms are more compact and take less time to be evaluating than the related PN structure. Also the search space is reduced since the number of places, transition and tokens is reduced. The overall effect is a shorter scheduling time and possibly a better solution to the problem.
Add interactive capability to the PN model: Finally, a PN model is a static individual that it is used only as an input to various analysis blocks. However the rule base addition gives the ability to create PNs that can relate with the environment in many ways:
Add high level control to the PN structure: In manufacture systems a high level of control is very important for the correct operation of the manufacturing system. The ability to model high level control is missing from fixed PN modelling.

Basic components of Petri Net

It mainly consist four objects:
Places
Transitions
Directed arcs
Tokens
Places representing a condition (pre conditions/post condition) that is activities.
Transitions representing events (It means corresponds to state change).
Directed arcs connect places to transitions.
Tokens present inside the places and their presence and absence indicated whether a condition with the corresponding places is true or false. Number of token

in the corresponding place also represents the number of available resources.

In the fig.1



The Set of places P is {p_1, p_2, p_3, p_4}
Set of transitions T is {t_1, t_2}
Input functions:
I (t_1) = {p_2, p_4}
I (t_2) = {p_2}
Output functions:
O (t_1) = {p_1}
O (t_2) = {p_3, p_3}

Properties of Petri Nets

Reachability:

Reachability helps in designing distributed systems to reach a specific state, or exhibit a particular functional behaviour. Checks the initialization conditions allows for all states to be reached.

Liveness:

It is closely related to the deadlock situations. Four conditions

1. Mutual exclusions: A resource is either available or allocated to process which has an exclusive access to resources.

2. Hold and wait: A process is allowed to hold a resource while requesting more resources.

3. Circular wait: Two or more process is arranged in a chain in which each process waits for resources hold by the process next in the chain.

4. No presumptions: A resources allocated to a process cannot be removed from the process, until it is released by the process itself.

Safeness and Roundness

Places are frequently used to represent storage area in communication and computer systems, product and tool storage areas in Production systems, etc. It is important to be able to determine whether proposed control the overflows of these storage areas. The information storage area can be hold, without corruption, only a restricted number of pieces of data. In production systems, attempts to store more tools, for instance in tool storage result in equipment damage. The Petri net property which helps to identify in the modeled system the existence of overflows is the existence of overflows is the concept of boundless.

2.8.4 Conservativeness

The number resources in the use are typically restricted by the financial as well as other constraints. If the tokens are used to represent resources, the number of which in a systems is typically fixed, then the number of tokens in a Petri net model of this system should remain unchanged irrespective of the marking the net takes on. A Petri net is conservative if the number of tokens is conserved. From the net structural point of view, this can only happen if the number of the input arcs to each transition is equal to the number of output arcs. However, in the real systems resources are frequently combined together so that certain tasks can be executed, then separated after the task is completed.

Types of Petri Nets

Coloured Petri nets

Developed in the late 1970s.Represent attributes of these objects, the Petri net model is extended with colour or typed tokens. Token often represent objects (e.g. resources, goods, humans) in the modeled system. Transitions use the values of the consumed tokens to determine the values of the produced tokens.A transition describe the relation between the values of the 'input token'.

Ordinary Petri nets

An ordinary type of Petri net modelling, graph asses circles to represent places and bars to represent transitions (events). Input-output relationships are represented by directed arcs between places and transitions. Black dots inside a circle or place called tokens. Tokens reside at a place when it is active. Tokens flow through the 'net' depending on the present marking of the net. The marking of Petri net is contained in a vector dimension n, where 'n' is the number of places and each value of the vector corresponds to the number of tokens in the corresponding places, when there is a token in each of the input places of a transition, that transition is enabled to fire. If the weights on each of the arcs between places and transitions are equal to one, then the transition fires by removing a token from each of its input places and by placing a token in each of its output places. In this type of Petri net one token is removed or added when a transition fires.

Weighted Petri nets:

This type allows the original Petri net to add or remove multiple tokens when a transition fires. The edges are number of tokens. If there is no label, then the default value is 1.

Time extended Petri nets:

First developed in the mid 1970s. For real systems it is often important to describe the temporal behaviour of the system, i.e. we need to model durations and delays. There are three basic ways to introduce time into the Petri net. Time can be associated with:

Places

Transitions

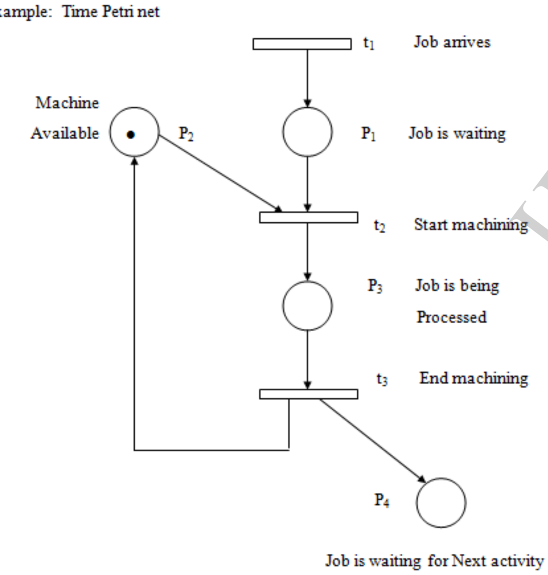
Token

Petri nets are in the Timed Petri net model:

In this model, time duration is associated with each transition. There are many other extensions to Petri nets that consider time. The firing rules in this model are that the transition must fire as soon as it is enabled, and firing a transition takes fixed, finite amount of time. The notation of instantaneous firing of transition is not preserved in the Time Petri net model.

In fig.

Example: Time Petri net



Benefits of Petri Nets

Requirement and theoretical representation. Reduced level of stock and work in progress. Dramatic graphical representation of models. Focus on interactions and dynamic relationships between systems' or processes' elements.

Capturing causality between events in complex processes. Modeling of concurrency and non-determinism. Rich set of formal tools for model analysis. Better product quality. Minimization of direct and indirect labor.

Application areas of Petri net:

1. Software design.
2. Workflow management.
3. Manufacturing process.
4. Process Modeling.
5. Data analysis
6. Concurrent programming.
7. Reliability engineering.
8. Discrete process control.
9. Simulation.
10. Finite state machine.
11. KPN modeling.

Why do we need Petri Nets in FMS?

Petri Nets can be used to carefully define a system (reducing ambiguity, making the operations of a system clear, allowing us to prove properties of a system etc.). They are often used for distributed systems (with several subsystems acting independently) and for systems with resource sharing. Since there may be more than one transition in the Petri Net active at the same time (and we do not know which will 'fire' first), they are non-deterministic.

Major Problem in FMS is Deadlock

In a flexible manufacturing system (FMS), different types of raw parts enter the system at discrete points of the time and are simultaneously processed, sharing a limited number of resources, such as robots, AGVs, machine tools, and buffers. In such a system, every raw part follows a pre established sequence of production steps. Each step requires certain system resources. These sequences are simultaneously executed and have to compete for a finite set of shared resources. This competition can cause deadlocks a highly undesirable situation.

According to Zhou Meng Chu, et al, 2008 deadlock and related blocking phenomenon often cause unnecessary costs such as long downtime and low use of some important and costly resources, and may lead to appalling results in some highly automated manufacturing system, such as semiconductor production systems. Therefore, it is a necessary requirement to develop an effective FMS control policy to make sure that Deadlocks will never occur in the system. This paper focuses on the deadlock problems in such FMS. Petri net are a major mathematical tool to model, analyze, and control deadlocks in various resources allocation systems, including FMS, and they are well suited to exhibit FMS behaviors, such as concurrency, conflict and causal dependency.

A powerful feature of Petri nets is their ability to represent good behaviour properties of the system, such as deadlock- freeness and boundedness. Many researchers use Petri nets as a formalism to describe the behaviour of FMS and to develop appropriate deadlock resolution methods. The major approaches using Petri nets techniques to cope with deadlocks in FMS are deadlock finding and improvement, deadlock prevention and deadlock avoidance. A deadlock detection and recovery approach permits the occurrence of deadlocks. As almost immediately a deadlock occurs, it is detected. Then the system is put back to a deadlock free state, by just real-locating the resources. The efficiency of this approach depends on the response time of the implemented algorithms for deadlock detection and recovery. In general these algorithms need large amounts of data and may become complex when more than a few types of shared resources are measured in a deadlock avoidance move toward, at each system state an on- line control policy is used to determine the correct system evolutions among the possible ones. The main purpose of this move toward is to keep the system away from deadlock states.

Although this move toward usually leads to better use of capital and high throughput, many computationally sufficient methods that fall into this type of deadlock control strategies do not totally eliminate all deadlocks. Therefore in this case if a deadlock arises, suitable improvement strategies are still necessary. Deadlock prevention is usually achieved either by effective system design or by using an off-line mechanism to control the requests for capital to ensure that deadlocks never occur. Monitors and related arcs are added to the original Petri net plant model to realize such mechanism. This implies that both a plant model and its controller are in a Petri net formalism.

Usually each possibly problematic smallest siphon requires a monitor to be added to prevent it from being emptied or insufficiently marked. Unfortunately the number of such siphons in a net grows quickly and in the worst case grows exponentially with the size of the net. Hence, the shortcoming of the existing methods is that they need to introduce too many additional monitors when the number of such siphons is large, leading to a much more complex controlled net system than the uncontrolled one plant model. To overcome this problem, the concept of ordinary Petri net was proposed.

Conclusion

This paper focuses on the basic understanding of Petri nets were adequate to handle part types and machining operations. If the modelled system is subsystem of a major one and the parts have to be processed by more than one machine, the number of token colours many become large as it is a combination of all processes do be done. A Petri net was able to include all the required properties of the produced parts in a much concise way. Reducing waiting time of raw material need to be process. Simplifies controller complexity through graphical analysis with the help of Petri net. Studying scheduling problems involving production system. Sequence controlling through Petri net helps in producing of variety of parts. Helps in performance evaluation of the modeled system. Work were used for developing program C language is used. This offers better understanding of the controlled scheduling. The ultimate result of my work has led to reduce cost saved time, removal of deadlocks in the system. All this has helped in better understanding of the complex manufacturing system.

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