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# Modeling and Implementing of an Automated Warehouse via Colored Timed Petri Nets

## a Behavior Perspective

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***Abstract*—The automated warehouse considered here consists of a number of rack locations with three cranes, a narrow aisle shuttle, and several buffer stations with the roller. Based on analyzing of the behaviors of the active resources in the system, a modular and computerized model is presented via a colored timed Petri net approach, in which places are multicolored to simplify model and characterize control flow of the resources, and token colors are defined as the routes of storage/retrieval operations. In addition, an approach for realization of model via visual c++ is briefly given. These facts allow us to render an emulate system to simulate a discrete control application for on-line monitoring, dynamic dispatching control and off-line revising scheduler policies.**

***Keywords-colored timed petri net (CTPN); automated warehouse; automated storage and retrieval system; modeling; multicolor***

## I. INTRODUCTION

Automated warehouses are computer-directed storage and transport facilities for large capacity and high volumes of handled materials. In a typical automated warehouse, it can be composed of three subsystems. The first one is called crane subsystem which consists of storage racks erected along aisles with the automated stacker cranes which travel within an aisle performing storage from buffer station and retrieval operations from racks; The next is shuttle subsystem, in which the shuttle machine transfers pallets from main input stations to the buffer stations with the roller; the third is buffer station subsystems which consisting of several buffer stations with the roller which provide transporting between crane subsystem and shuttle subsystem. The case addressed in this paper is more general than others presented in the literatures [1,2,3,4,5,6],since the presence of the buffer station subsystem is considered.

A two-hierarchical control structure is proposed at the system operational level [4]; the first is called the scheduler, which decides a control strategy on the basis of current subsystems' state in order to maximize the system throughput; It receives from a higher scheduler system loading /unloading orders with a set of possible destinations in different aisle and produces the route for a pallet, crane or shuttle. The other is the resource controller, which receives and fulfils the route from the scheduler. The model in the paper aims to the resource controller. In the resource controller level, the main and almost operations are resource-oriened, therefore, it is necessary for modeling the resource controller system to study the behavior of resources, especially for active resources consisting of the pallets, the cranes and the shuttle. The behaviors of resources are divided seven types in the paper, and the control flow of automated warehouse is unified of all these types of the behaviors.

Colored Timed Petri Nets(CTPN) have resulted to be effective tool for automated warehouse modeling [4,6,8,9].The literature[4] proposed a CTPN model to describe in concise and efficient way the dynamics of an AS/RS (automated storage and retrieval system) serviced by rail guided vehicles in control perspective; The literature[6] obtained model modularity of AS/RS by CPN,which was decomposed in six modules which communicates via fusion places. However, in these literatures [4,6,8,9],the behaviors of resources are not clearly clarified in modeling, so that not only the model intends to complex, but also the information of the system easily loses. This paper aims to model automated warehouse in fig 1 based on the behaviors of resources via CTPN in modular way, and the model is to be more concise and more conveniently computerized; in addition, the approach of CTPN here is to multicolor places in order to simplify the model and characterize control flow of the resources.

The paper is organized as follows: in section 2 an automated warehouse under study is described, including its control structure and analyzing of its active resources' behaviors; in section 3, following a brief approach of CTPNs,a modular model of behaviors of active resources is explained; in section 4, the approach of realization for model in section 3 via visual c++ is briefly given; finally, several concluding remarks are reported.

## II. SYSTEM DESCRIPTION AND BEHAVIOR ANALYSIS E

An automated warehouse considered here is decomposed into three subsystems (see fig1): crane subsystem, buffer station subsystem and shuttle subsystem. In crane subsystem, each narrow aisle stacker crane serves two storage racks, the marks 101,111,134 in fig 1 represent crane input stations from which crane carries a pallet and transfers to the rack location; the marks 106,117,127 represent crane output stations to which crane transfers a pallet from rack locations. In buffer station subsystem, each buffer station is equipped with the roller, a pallet can be transferred between consecutive buffer stations. In shuttle subsystem, there are three main input stations and one shuttle.

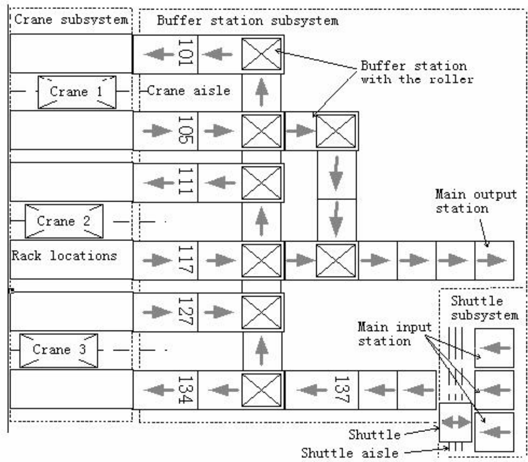


Figure 1. Automated warehouse layout.

In order to identify all resources, the automated warehouse layout in fig 1 is marked in fig 4,where v denotes the shuttle, its aisles are divided into three positions:$pv_1$,$pv_2$ and $pv_3$;$rs_1$,$rs_2$ and $rs_3$ represent three cranes;$p_{29}$,$p_{30}$,$p_{31}$ are three cranes' home positions;$p_{01}$,$p_{02}$ and $p_{03}$ are main input stations,$p_3$ is main output station, others are buffer stations,thereinto,$p_{15}$,$p_{16}$, $p_{19}$ and $p_{25}$ is shared buffer stations which can transfer storage/retrieval pallets. On the other hand, for sake of simplicity, it is supposed that every crane serves two racks, each with four locations; Fig 2 shows the rack locations and crane positions where crane $rs_3$ can shift.

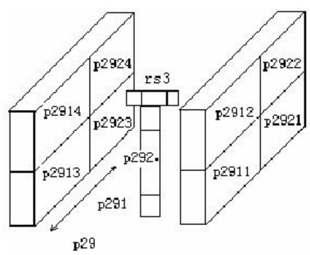


Figure 2. Example of a crane servicing two opposite racks.

## A. Hierarchical Control Structure

In control system of automated warehouse, A two-hierarchical control structure (see fig 3) is proposed at the system operational level [4], the first is called the scheduler, which decides a control strategy on the basis of current subsystems' state(in fig 3,the arrow to the scheduler from the resource controller is omitted) in order to maximize the system throughput; it receives from a higher scheduler system loading/ unloading orders with a set of possible destinations in different aisle; it produces the route for a crane, a shuttle or a pallet, and assigns shared buffer stations to carry a pallet in their consecutive stations; the other is the resource controller, which receives and fulfils the route from the scheduler. The model in the paper aims to resource controller.

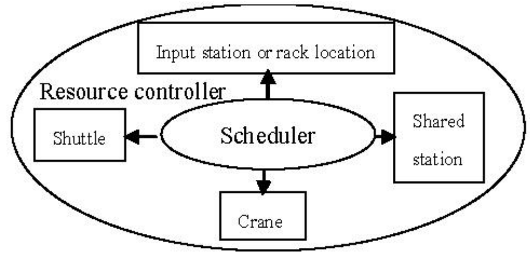


Figure 3. Hierachical Control Structure.

## B. The Workflow of Resource Controller

*1)The storage operation:* When a new pallet arrives at one of main input station, the scheduler assigns a storage route to the pallet which starting from main input station, following a certain number of shuttle aisle locations to several buffer stations and a certain number of crane aisle locations to the corresponding rack location. i.e. when a pallet in $p_{01}$ is to be stored in storage location $p_{2924}$, the scheduler will assign such route to the pallet as $p_{01}\rightarrow pv_1\rightarrow pv_2\rightarrow p_{12}\rightarrow p_{13}\rightarrow p_{14}\rightarrow p_{15}\rightarrow p_{16}\rightarrow p_{17}\rightarrow p_{18}\rightarrow p_{19}\rightarrow p_{20}\rightarrow p_{21}\rightarrow p_9\rightarrow p_{29}\rightarrow p_{291}\rightarrow p_{292}\rightarrow p_{2924}$; then the shuttle $v$ is booked, loads the

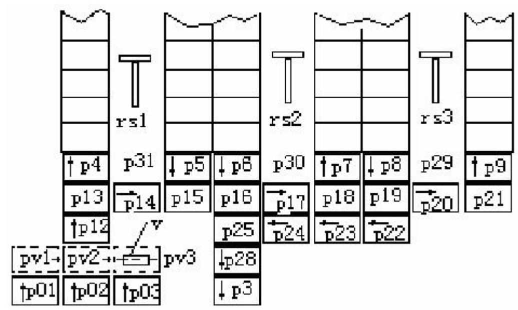


Figure 4. Automated warehouse marked layout.

pallet from $p_{01}$and transfers to $p_{12}$; the buffer stations then transmit it to $p_9$, finally, the crane is booked and carries it from $p_4$ and sends to rack location $p_{2924}$.

*2)The retrieval operation:* If a pallet is to be retrieved, a crane will be booked by scheduler to travel to the rack location and loads it to buffer station(i.e.$p_5$,$p_6$ and $p_8$),then the pallet will be transferred to main output station $p_3$.A route of the pallet assigned by the scheduler is like:$p_{2924}\rightarrow p_{292}\rightarrow p_{291}\rightarrow p_{29}\rightarrow p_8\rightarrow p_{19}\rightarrow p_{22}\rightarrow p_{23}\rightarrow p_{24}\rightarrow p_{25}\rightarrow p_{28}\rightarrow p_3$.

## C. The Behavior of Active Resources

In resource controller level, the main and almost operations are resource-oriened, therefore, it is necessary for modeling the resource controller system to study the behavior of resources, especially for active resources consisting of pallets, cranes and the shuttle. It is the behaviors of these resources that can change the control system' state. A route of an active resource represents a set of places along which an active resource can be transited. In following sections, the main study aims to analyze the behaviors of active resources and classify them, in section 3, and then a CTPN is applied to model the events of these behaviors.

Firstly, the behaviors of a pallet include getting the route, loaded, transferred and unloaded by the shuttle or a crane, t-ransmitted by buffer stations. Secondly, the behaviors of the shuttle or a crane is composed of getting route from the scheduler, loading and unloading one pallet, and moving between shuttle or crane aisles with a pallet or not.

Being considered enabling conditions of these behaviors and their results fired, seven types of behaviors are identified as follows:

1-type behavior: called entering. When a pallet enters the system or is to be retrieved, the scheduler will assign a route to this pallet; the result is that the pallet will get the route.

2-type behavior: called loading. A pallet is to be loaded by a booked shuttle/crane. Including that the booked shuttle loading a pallet from main input station,and a booked crane loading a pallet from buffer stations/rack locations. The result is that the pallet will enter the shuttle or crane; its route will be changed with cutting current place, which represents that a shuttle or crane has carried a pallet, then, the information of the pallet's current place will be cleared.

3-type behavior: called transferring. A booked or loaded shuttle/crane shifts, or a pallet is transferred between cone-scutive buffer stations. The result is that the pallet, the shuttle or the crane enters next place; its route will be changed with cutting current place, and the information of current place will be cleared.

4-type behavior: called unloading. The shuttle or a crane unloads a pallet into the buffer station or rack location. The result is that the pallet enters a buffer station or rack location and its route will be changed with cutting current place, and the shuttle or a crane becomes idle in current place.

5-type behavior: called booking. The shuttle or a crane is booked by the scheduler to carry a pallet. A route from curre-nt place to place of the pallet will be assigned by the schedu-ler. The result is that the shuttle or a crane gets this route.

6-type behavior: called sharing. When one more pallets is enabled to transfer to shared buffer stations such as $p_{15}$, $p_{16}$, $p_{19}$ and $p_{25}$, the scheduler will give an instruction to shared buffer stations to tell which pallet can be loaded.

7-type behavior: called leaving. A pallet is to leave from main output station. The result is that the information of main output station will be cleared.

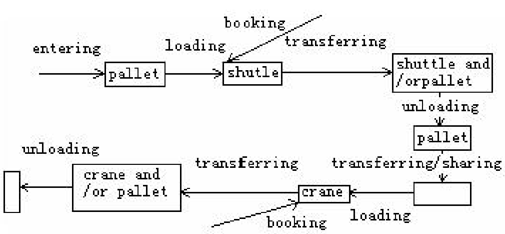


Figure 5. The process of storage operation.

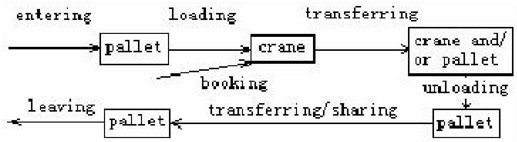


Figure 6. The process of retrieval operation.

Based on seven types of behaviors mentioned above, the process of storage/retrieval operation in automated warehouse can be described as fig 5 and fig 6.

## III. MODELING OF THE SYSTEM VIA CTPN

This section describes the CTPN modeling seven type be-haviors mentioned above. A modular and resource-oriented CTPNs model is proposed. In particular, places are such sta-tions as main input/output stations, buffer stations, rack loc-ations, and crane/shuttle aisle places; tokens are the pallets, the shuttle and the cranes, while token colors represent the storage/retrieval routes. In addition, transitions model events of seven-type behaviors of the active resources. In the following section we briefly review such modeling approach.

### A. *The approach of CTPN modeling the System*

The CTPN setting extends the framework of PN by adding color, time and modular attributes to the net [7]. The color attribute is developed to deal with systems that have similar or redundant logical structures[6]. The time attribute allows various time-based performance measures to be added in the system model. A time delay can be assigned to places to model the time properties of a system. We assume that the reader already knows concepts and terminology of Colored Petri Nets (CPN). Nevertheless, [4,7,8]can be consulted about the overview of CTPN.Let us briefly describe the approach of CTPN modeling the system shown in fig 1.

A colored timed Petri net is a 9-tuple $CTPN = (P,T, Co,Inh,C_+,C_-,\Omega,Ti,Mo)$where $P$ is a set of places,$P=Pp \cup P'$ , $P'$ is a set of virtual places which are introduced to accommodate instructions from the scheduler, $Pp=Pv \cup Pin \cup Pc \cup Prs \cup Prl \cup Pout \cup Psc$.$Pin=\{p_{01},p_{02},p_{03}\}$, $Pout=\{p_3\}$,$Prs$ is a set of the crane aisle places, $Pv=\{pv_{01},pv_{02},pv_{03}\}$,$Pc$ is a set of buffer stations,$Psc=\{p_{15},p_{16},p_{19},p_{25}\}$,and $Prl$ is a set of rack locations;$p$ denotes one place;$T$ is a set of transitions modeling events of seven-type behaviors mentioned in section 2,$t$ denotes one transition; Tokens represent the pallets, the shuttle, three cranes and instructions from the scheduler; in particular,tokens here are colored with a route such as $<p_i,p_m,\ldots,p_n>,p_i,p_m\ldots,p_n \in Pp$;$Co$ is a set of nonempty types, called color sets,$Co(P)$ is a set of $p \in P$,$Co(p)$ is the token color in $p \in P$,$Co(T)$ is a set of $t \in T$ and $Co(t)$ represents two consecutive $p \in Pp$.$Inh$ is a weight function for an inhibitor arc which connects a $t \in T$ to a $p \in Pp$,here $Inh(p,t)=1$,$Inh$ implies that a transition $t$ can be enabled if $p$ does not contain any token.$C_+(P,T)$ and $C_-(P,T)$ are the post-incidence and the pre-incidence $|P|\times|T|$ matrices respectively. In particular, a transiton $t \in T$ is enabled at a marking $M$ with respect to a color $c \in Co(t)$ iff for each $p \in {}^{\cdot}t$, $M(p) \geq C_-(p,t)(c)$:this is denoted with $M\{t(c)>$. When fired, new marking $M'(p)=M(p)-C^-(p,t)(c)+C^+(p,t)(c)$.

The set $\Omega$ is defined as follows: $\Omega = \cup_{x \in P \cup T}\{C(x)\}$. *Mo* is the initial marking of the net.

Definition 1: a transition $t_{i,m}$ represents a token in $p_i \in Pp$ is to be transferred from $p_i \in Pp$ to $p_m \in Pp(i,m \in N)$,and:

$$Co(token) = < p_i, p_m, \ldots >;$$
$$Co(p_i) = Co(token); Co(p_m) = 0;$$
$$C^-(p_i, t_{i,m})(c) = < p_i, p_m >;$$
$$C^+(p_m, t_{i,m})(c) = Co(p_i) - < p_i >;$$
$$M(p_i) = Co(p_i), M(p_m) = Co(p_m).$$

Definition 2:$M(p_i)=<p_i>$ describes that a pallet is in $p_i$ and with no route if $p_i \in Prc$, a shuttle is in $p_i$ and idle if $p_i \in Pv$, or a crane is in $p_i$ and idle if $p_i \in Prs$.

Definition3:If $P_1 \subset P, P_1 = \{p_1, p_2, \ldots, p_n\}, n \in N$ ,and a colored token in $p_i \in P_1$ ,then the color $Co(P_1)$ of $P_1$ is $<p_1,p_2,\ldots p_n>$,and the color $Co(p_i)$ of $p_i$ is token color. Such is called places multicolor.

Then, to investigate the performance of system, a global clock $\tau \in \overline{N}$ is introduced[4];moreover, $Ti$ is a set of $ti \in \overline{N}$, $ti : Pp \rightarrow \overline{N}$ ,where $ti(p)$ describes the earliest time at which a token in $p \in Pp$ can be removed by enabled transition. In addition to token colors,a time stamp $\lambda$ is attached to each.$\lambda(p)$ is reset as soon as the token arrives in the $p \in Pp$.If $\lambda(p) \geq ti(p)$,then the transition enabled by the considered token is ready for execution.

### B. Modeling the Behaviors of Active Resources

In following subsections, The CTPN is applied to model the behaviors of active resources, and a rectangle shows a virtual place $p'$; if following transition fired, the information in virtual place $p'$ will be cleared.

#### 1) The CTPN modeling entering behavior

The dynamics of entering behavior is modeled by the CTPN in fig 7.$P'$ is a set of virtual places,$P_i = Pin \cup Prl$,$T_{P',Pi}$ describes events that the scheduler assigns a route to the pallet in $P_i$ for storage or retrieval.

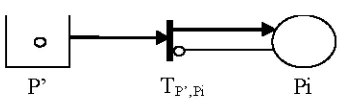


Figure 7. The CTPN modeling entering behavior.

For each $t \in T_{P',Pi}$,its enabling conditions are:

A1) $M(p_i) = 0, p_i \in Pin; M(p_i) = < p_i >, p_i \in Prl.$

A2) $M(p') = < p_i, \ldots >.$

If $t \in T_{P',Pi}$ is ready and fires, then the new marking $M'$is the following:

$$M'(p_i) = < p_i, \ldots > \quad (1)$$

$$M'(p') = 0 \quad (2)$$

Then $\lambda(p_i)$ is reset and begins to count.

#### 2) The CTPN modeling loading behavior

Fig 8 shows loading behavior.including the shuttle loading a pallet from $p_{01}$,$p_{02}$ and $p_{03}$,or the crane loading a pallet from buffer stations or rack locations.

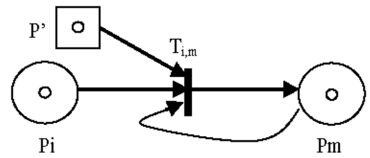


Figure 8. The CTPN modeling loading behavior.

In fig 8, $Pi = Pin \cup Prl \cup \{p_4, p_7, p_9\}$;$P_m = Pv \cup Prs$.Here,if $p_i$ is one of elements in $Pin$,then $p_m \in Pv$;else $p_m \in Prs$.$T_{i,m}$ describes that a pallet with the route will be loaded into a shuttle or a crane from $P_i$ to $P_m$. $P'$ is a set of virtual places containing the instructions that which pallet the shuttle or a crane is to carry.

For each $t_{i,m} \in T_{i,m}$,if $p_m \in P_m$,$p_i \in P_i$ and $p' \in P'$ ,its enabling conditions are:

B1) $M(p_m) = < p_m >.$ B2) $\lambda(p_i) \geq ti(p_i).$

B3) $M(p_i) \geq C^-(p_i, t_{i,m})(c) = < p_i, p_m >.$

B4) $M(p') = C^-(p', t_{i,m})(c) = < p_i, p_m >.$

If $t_{i,m} \in T_{i,m}$ is ready and fires,then the new marking $M'$is the following:

$$M'(p_m) = C^+(p_m, t_{i,m})(c) + M(p_m) = < p_m, \ldots > \quad (3)$$

$$M'(p_i) = 0 \quad (4)$$

$$M'(p') = 0 \quad (5)$$

Then $\lambda(p_m)$ is reset and begins to count.

#### 3) The CTPN modeling unloading behavior

Unloading behavior includes that the shuttle unloading the pallet into buffer station and crane unloading the pallet into rack location or buffer station, shown fig 9.

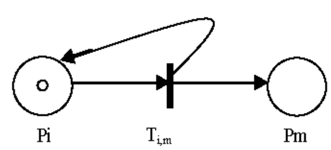


Figure 9. The CTPN modeling unloading behavior.

$P_i$=$Pv \cup Prs$,$P_m$={$p_{12}$,$p_5$,$p_6$,$p_8$} $\cup$ $Prl$.Here,if $P_i$=$Pv$,then $p_m$ is $p_{12}$;else $p_m \in (Pr \cup \{p_5, p_6, p_8\})$;$T_{i,m}$ describes that a pallet in the shuttle/crane will be unloaded from $P_i$ to $P_m$.

For each $t_{i,m} \in T_{i,m}$,if $p_m \in P_m$ and $p_i \in P_i$,its enabling conditions are:

C1) $M(p_m) = 0$. C2) $\lambda(p_i) \geq ti(p_i)$.

C3) $M(p_i) \geq C^-(p_i, t_{i,m})(c) =< p_i, p_m >$.

If $t_{i,m} \in T_{i,m}$ is ready and fires, then the new marking $M'$is the following:

$$M'(p_m) = C^+(p_m, t_{i,m})(c) + M(p_m) =< p_m, \ldots > \quad (6)$$

$$M'(p_i) =< p_i > \quad (7)$$

Then $\lambda(p_m)$ is reset and begins to count.

*4) The CTPN modeling transferring behavior*

Fig 10 shows the CTPN model of transferring behavior.

$P_i$,$P_m$=$Pv \cup Prs \cup Pc$;Here,either $P_i$,$P_m$=$Pv$,or $P_i$,$P_m$=$Prs$,or $P_i$,$P_m$=$Pc$;$T_{i,m}$ describes events of all transferring behavior.

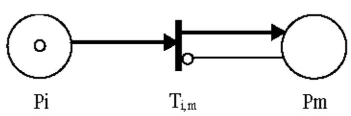


Figure 10. The CTPN modeling transferring behavior.

For each $t_{i,m} \in T_{i,m}$,if $p_m \in P_m$ and $p_i \in P_i$,its enabling conditions are:

D1) $M(p_m) = 0$. D2) $\lambda(p_i) \geq ti(p_i)$.

D3) $M(p_i) \geq C^-(p_i, t_{i,m})(c) =< p_i, p_m >$.

If $t_{i,m} \in T_{i,m}$ is ready and fires,then the new marking $M'$is the following:

$$M'(p_m) = C^+(p_m, t_{i,m})(c) + M(p_m) =< p_m, \ldots > \quad (8)$$

$$M'(p_i) = 0 \quad (9)$$

Then $\lambda(p_m)$ is reset and begins to count.

*5) The CTPN modeling leaving behavior*

In fig 11, $p_3$ is main output station, $T_{3,0}$ describes a pallet is to leave the system.

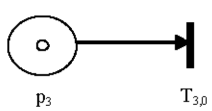


Figure 11. The CTPN modeling leaving behavior.

For each $t_{3,0} \in T_{3,0}$,its enabling conditions are:

E1) $M(p_3) =< p_3, 0 >$. E2) $\lambda(p_3) \geq ti(p_3)$.

If $t_{3,0}$ is ready and fires, then the new marking M'is the following:

$$M'(p_3) = 0 \quad (10)$$

*6) The CTPN modeling sharing behavior*

In fig 2, when a storage pallet, i.e. in $p_{14}$ and a retrieval pallet in $p_5$ arrives at the same time, the conflict will occur in $p_{15}$.in such condition, the scheduler will intervene; here $p_{15}$ is called a sharing station($Psc$={$p_{16}$,$p_{15}$,$p_{19}$, $p_{25}$}). Fig 12 shows the CTPN model of such sharing operation.

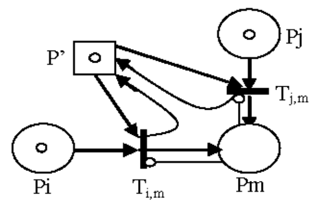


Figure 12. The CTPN modeling sharing behavior.

In fig 12, $P'$ is a set of virtual places containing the instructions that decide either $T_{i,m}$ or $T_{j,m}$ is to occur. Here, ($P_i$,$P_j$,$P_m$) is {($p_{14}$,$p_5$,$p_{15}$); ($p_{15}$,$p_6$,$p_{16}$); ($p_{18}$,$p_8$,$p_{19}$); ($p_{24}$,$p_{16}$,$p_{25}$)}; $T_{i,m}$($T_{j,m}$) describe a pallet in $P_i$($P_j$) is to be transferred to $P_m$.

For each $t_{i,m} \in T_{i,m}$,if $p_m \in P_m$ and $p_i \in P_i$,its enabling conditions are:

F1) $M(p_m) = 0$. F2) $\lambda(p_i) \geq ti(p_i)$.

F3) $M(p_i) \geq C^-(p_i, t_{i,m})(c) =< p_i, p_m >$.

F4) $M(p') =< p_i, p_m >$.

If $t_{i,m} \in T_{i,m}$ is ready and fires,then the new marking $M'$is the following:

$$M'(p_m) = C^+(p_m, t_{i,m})(c) + M(p_m) =< p_m, \ldots > \quad (11)$$

$$M'(p_i) = 0 \quad (12)$$

$$M'(p') =< p_j, p_m > \quad (13)$$

Then $\lambda(p_m)$ is reset and begins to count.

$M'(p') =< p_j, p_m >$ denotes that a pallet in $p_i$ has been transferred into $p_m$, the next operation is $T_{j,m}$. For each $t_{j,m} \in T_{j,m}$ the operation is similar to $t_{i,m} \in T_{i,m}$.

*7) The CTPN modeling booking behavior*

In fig 13, $P_i$=$Pv \cup Prs$.For each $t \in T_{P',Pi}$, its enabling conditions are:

G1) $M(p_i) =< p_i >$. G2) $M(p') =< p_i, \ldots >$.

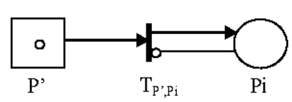


Figure 13. The CTPN modeling booking behavior.

If $t \in T_{P',Pi}$ is ready and fires,then the new marking $M'$is the following:

$$M'(p_i) = < p_i, ... > \quad (14)$$

$$M'(p') = 0 \quad (15)$$

$M'(p_i) = < p_i, ... >$ denotes a shuttle or a crane is booked with a route from current location to destination for loading.

## IV. IMPLEMENTING MODEL OF CTPN WITH VISUAL C++

Based on the approach of the CTPN modeling seven-type behaviors of the active resources in automated warehouse described above, the simulations of the whole system can be performed in the Visual C++6.0 environment, where seven transition functions emulate the seven-type behaviors. The whole system is mainly composed of the scheduler subsystem and the resource controller subsystem which includes such the modules as class defining, main process, the seven transition functions and several auxiliary functions and procedures; due to space limitation, only the flow chart of main process module is briefly given in fig 14.

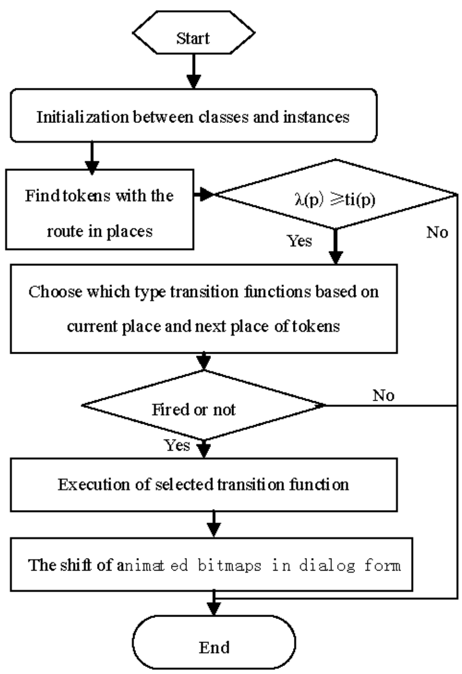


Figure 14. The flow chart of main process of the resource controller module.

In main process module, a dialog form simulates the work flow of all resources in fig 1,and many animated bitmaps describe the shift of the active resources. When one of transition functions has been chosen, it's enabling conditions base on either A1-A2, or B1-B4, or C1-C3, or D1-D3, or E1-E2, or F1-F4, or G1-G2;then fired, new marking M' is updated either according to equations (1)-(2),or (3)-(5),or (6)-(7),or (8)-(9),or (10),or (11)-(13),or (14)-(15).

## V. CONCLUDING REMARKS

CTPN results to be effective for modeling the resource-oriented systems such as the automated warehouse. It is necessary for modeling resource-oriented systems to analyze the behaviors of the resources, especially for active resources. Based on study of the behaviors of the active resources, the dynamics of an automated warehouse can be modeled with CTPN in a concise and efficient way,in which places are multicolored.The paper defines in detail the CTPN modeling each event of the behaviors in the system: the pallet entering the system, the pallet being transferred/loaded/unloaded, a pallet leaving from system, a crane or a shuttle being booked or shifting, and a buffer station being shared. To do so, the implement of the model becomes easier via Visual C++. The approach allows us to obtain a resource-oriented model suitable for real-time control applications. Further study on developing the scheduler model and designing favorable dispatch policies to improve the whole system performances is now in progress.

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