ANALYSIS OF DIGRAPHS OF BASIC STOCK CONTROL SYSTEM AND SIMULTANEOUS KANBAN CONTROL SYSTEM

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Abstract

This paper is an extension of one of the previous papers published by same authors. Here we convert the two marked graphs of Basic stock control system and simultaneous kanban system in two methods. First we change transitions into edges and places into vertices. Then we change both the transitions and places into vertices and the arcs into edges. Then we study of the graph theoretic properties of six digraphs including those found out in previous paper.

AMS Subject Classification: 05c20

1 Introduction

A Petri net is a powerful modeling formulation in computer science and similar disciplines. A Petri net combines a well-
defined mathematical theory with a graphical representation of the dynamic behavior of the system the theoretic aspects of Petri net allows precise modeling and analysis of system behavior while the graphical representation of Petri net enables visualization of the modeled system state change. Because of this Petri net has been used to model various kinds of dynamic event driven system like computer networks, communication system, manufacturing plant etc.

Basics of Petri nets are given in [1, 2]. Conversion of Petri nets into digraphs are given in [3, 4, 6]. We take two Petri net models of two different FMSs from [5] and convert them into digraphs in two new methods suggested in [6]. Other graph theoretic properties of the six digraphs are analysed according to [15]

The organisation of the rest of the paper is as follows. Section-II contains basic definitions. Section-III contains marked graphs in to digraphs. Section-IV contains the analysis of graph theoretic properties of the digraphs. Section V contains Conclusion and References.

2 Definitions

Definition 1. A marked Petri Net is $N = (P, T, F, W, M_0)$, where $P$ is a finite set of places, $T$ is a finite set of transitions, with $P \cap T = \emptyset$, $F \subset (P \times T) \cup (T \times P)$ is the incidence or flow relation (each element of $F$ corresponds to an arc in the $PN$), $W : F \rightarrow \mathbb{N}\{0\}$ is the arc weight function, and $M_0 : P \rightarrow \mathbb{N}$ is the initial marking (a marking $M : P \rightarrow \mathbb{N}$ defines the distribution of tokens in places), where $\mathbb{N}$ is the set of natural numbers. [1, 2]

Definition 2. Flexible Manufacturing System. A FMS) is an integrated computer controlled configuration of machine tools and automated material handling devices that simultaneously process medium sized volumes of a variety of part types. Flexible manufacturing system is a discrete event dynamical system in which the work pieces Of various job classes enter the system asynchronously and are Concurrently, sharing the limited resources, viz., workstations, robots, MHS, buffrs and so on.
**Definition 3.** Diagraph A directed graph $G$ consists of a set of vertices $V = \{v_1, v_2, \ldots\}$ and a set of edges $E = \{e_1, e_2, \ldots\}$ and a mapping $\psi$ that maps every edge onto some ordered pair of vertices $(V_i, V_j)$. [15]

**Definition 4.** Euler Digraph: In a digraph $G$ a closed directed walk which traverses every edge of $G$ exactly once is called a directed Euler line. A digraph containing a directed Euler line is called directed Euler digraph. [15]

**Theorem 5.** A digraph $G$ is an Euler digraph if and only if $G$ is connected and is balanced i.e. $d^-(v) = d^+(v)$ for every vertex $v$ in $G$. [15]

**Definition 6.** Chromatic no. It is the number of colours required to do proper colouring of a graph. i.e. No adjacent vertices have the same colour.

### 3 Conversion of Marked graphs into digraphs

#### 3.1 Conversion of Marked Graph of Basic Stock Control System

According to [6] there are three methods to convert a Petri nets into digraphs. They area

1. Changing transitions into vertices and places into edges.
2. Changing transitions into edges and places into vertices.
3. Changing both transitions and places into vertices and arcs between them into edges.

The following marked graph is the Petri net model of Basic Stock control system found in [5]. The same authors analysed the marked graph in [12] and found out the set of places which are both siphons and traps. We converted the marked graph into digraph in [9] by changing transitions into vertices and places into edges in (First method). The resulting digraph is not Euler digraph as $d^+(v_3) = 2$, $d^-(v_3) = 1$. [Theorem 1.6].

\[\text{Digraph1}\]
Now we convert the above marked graph into digraph in the second method stated above. i.e. changing transitions into edges and places into vertices [6]. The resulting digraph is given below.

-Digraph 2. The resulting digraph is not Euler digraph as $d^+(v_5) = 2$, $d^-(v_5) = 1$. [Theorem 1.6]
digraph is given below. -Digraph 3. The resulting digraph is not Euler digraph as $d^+(v_7) = 2$, $d^-(v_7) = 1$. [Theorem 1.6]

Figure 4: Digraph 3

3.2 Conversion of Marked Graph of Simultaneous Kanban Control System

The following marked graph is the Petri net model of simultaneous kanban control system found in [5]. The authors analysed the marked graph in [12] and found out the set of places which both are siphons and traps. We converted the marked graph into digraph in [9] by changing transitions into vertices and places into edges. (First method) The resulting digraph is not Euler digraph as $d^+(v_4) = 2$, $d^-(v_4) = 0$. [Theorem 1.6] -Digraph 4

Figure 5: Marked graph of Simultaneous kanban control system
Now we convert the above marked graph into digraph in the second method stated above. i.e. changing transitions into edges and places into vertices [6]. -Digraph 5 The resulting digraph is given below. The resulting digraph is not Euler digraph as $d^+(v_7) = 2$, $d^-(v_1) = 1$. [Theorem 1.6]

Now we convert the above marked graph into digraph in the third method stated above. i.e. changing transitions and places into vertices and arcs between them as edges [6]. The resulting digraph is given below. The resulting digraph is not Euler digraph as $d^+(v_8) = 2$, $d^-(v_8) = 1$. [Theorem 1.6] -Digraph 6
Figure 8: Digraph 6

4 Analysis of the digraphs

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5 Conclusion & References

Conclusion: In this paper we extend our conversion of Petri nets in to digraphs from our previous paper. None of the digraphs are Euler digraphs. One or two directed circuits were found in each of the digraphs. Chromatic no were 2 or 3.

References


