ANALYSES OF DIGRAPHS OF NON-DEAD LOCK FREE FMS AND MACHINING STATION WITH FOUR MACHINES AND TWO ROBOTS

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Abstract: In this paper two Petri net models of two different FMS are taken and converted into digraph. Interestingly both of them are found to be Euler digraphs. Further the graph theoretic properties of digraphs are analysed.

Keywords: Petri Nets, FMS, Digraph, Euler Digraph.

Introduction: A Petri net is a powerful modeling formulation in a computer science, system engineering and many others 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.

Petri net are introduced in [1,2] conversion of Petri nets into digraphs are given in [4].We take two Petri net models of two different FMS s from [3] and convert them into digraphs. Interestingly both of them are Euler digraphs. Other graph theoretic properties of the two digraphs are analysed according to [7].

Definition 1.1: A PN is a bipartite graph, where nodes are classified as places and transitions (graphically pictured as circles and bars, respectively), and directed arcs connect only nodes of different type. Places are endowed with integer variables called tokens. A marked PN is a 5-tuple N = (P, T, F, W, M_0), where P is a finite set of places, T is a finite set of transitions, with $P \cap T = \emptyset$,$F \subset (PxT) U (T x P)$ is the incidence or flow relation (each element of F corresponds to an arc in the PN), W : F —> N \ {0} is the arc weight function, and M_0: P —> N is the initial marking (a marking M : P —> N defines the distribution of tokens in places), where N is the set of natural numbers.[1,2]

Definition 1.3: Flexible Manufacturing System: A Flexible manufacturing system (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 1.4: Diagraph A directed graph G consists of a set of vertices V = {v_1,v_2,....} and a set of edged E={e_1,e_2,....} and a mapping ψ that maps every edge onto some ordered pair of vertices (V_i,V_j).[7]

Definition 1.5: 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..[7]

Theorem 1.6: 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.[7]

3. Conversion of Petri net models of a non-deadlock free FMS and a FMS with Four Machines and Two Robots:

3.1: In this sub section we take the Petri net model of non deadlock free FMS from [3] and the Petri net obtained by adding a control place Fig-1.First we consider the Petri net without the control place added. We convert this Petri net into a digraph by the method given in [4].That is by changing transitions into vertices and places into edges. The result is as shown in Fig-2.Interstingly the digraph so obtained is Euler digraph by theorem1.6 as $d(v^+) = d(v^-)$ for each vertex.

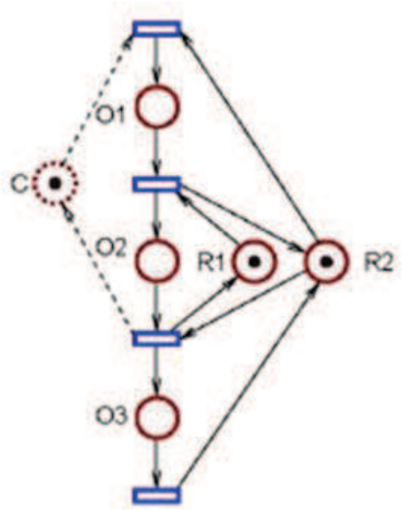

Fig 1

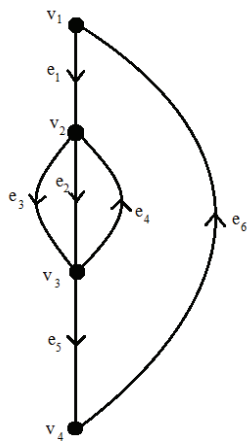

Fig 2

Next we consider the Petri net with the control place added. We convert this Petri net into a digraph by the method given in [4].That is by changing transitions into vertices and places into edges. The result is given in Fig-3.This digraph is also an Euler digraph by theorem 1.6.

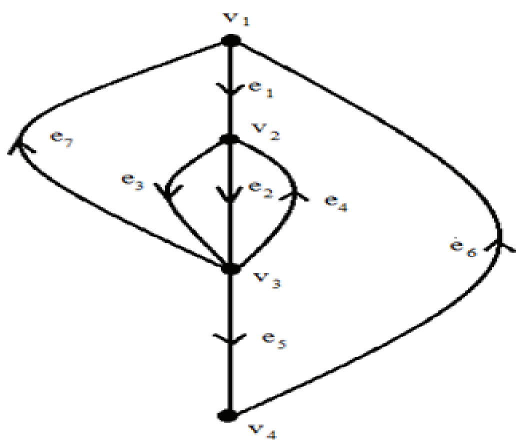

Fig 3

3.2: In this sub-section we take the Petri net model of the machining station with four machines and two robots and convert it into dir\graph by the method given in [4].In Fig- 4 the FMS is given. In Fig- 5 the Petri net model is given. In Fig-6 the converted Digraph is given which is also an Euler digraph by theorem 1.6.

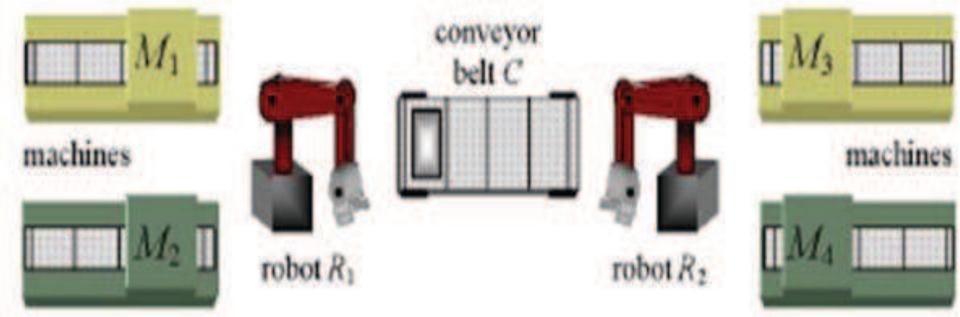

Fig 4

In this sub-section we take the Petri net model of the machining station with four machines and two robots and convert it into dir\graph by the method given in [4].In Fig- 4 the FMS is given. In Fig- 5 the Petri net model is given. In Fig-6 the converted Digraph is given which is also an Euler digraph by theorem 1.6.

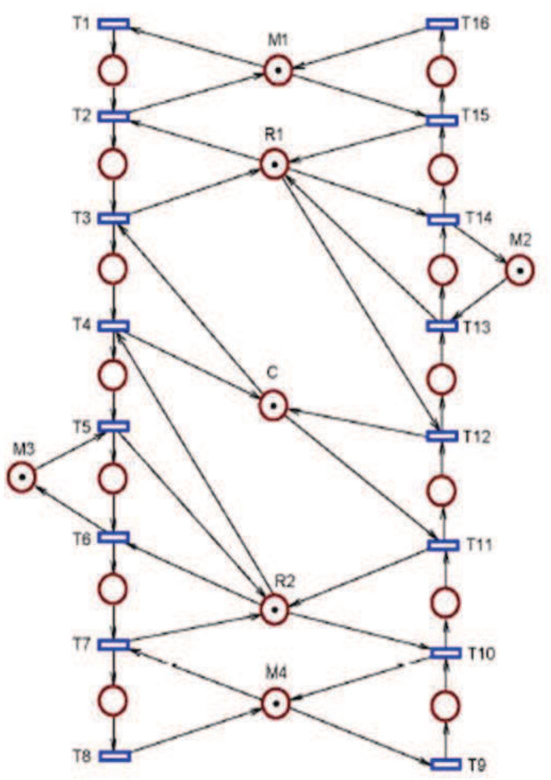

Fig 5

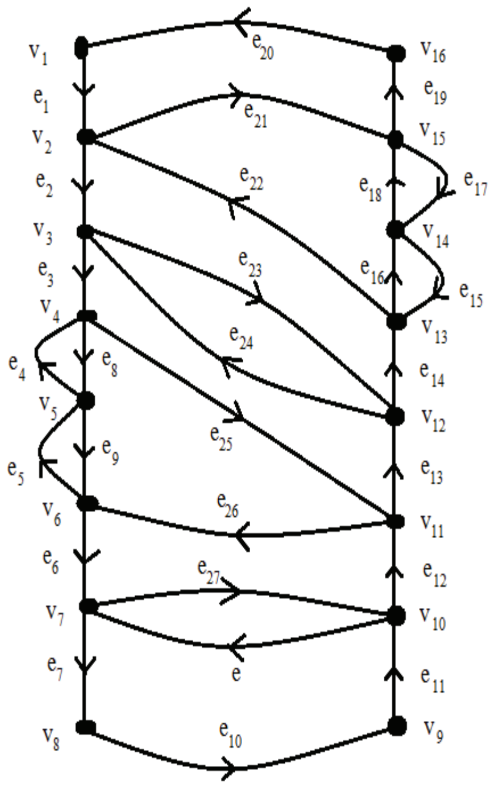

Fig 6

3.3: In this sub-section we take the AB- model of the machining station with four machines and two robots and convert it into dir\graph by the method given in [4]. In Fig- 7 the Petri net model is given. In Fig-8 the converted Digraph is given which is not an Euler digraph by theorem 1.6 as $d^-(v_2) = 2$,but $d^+(v_2)=4$.

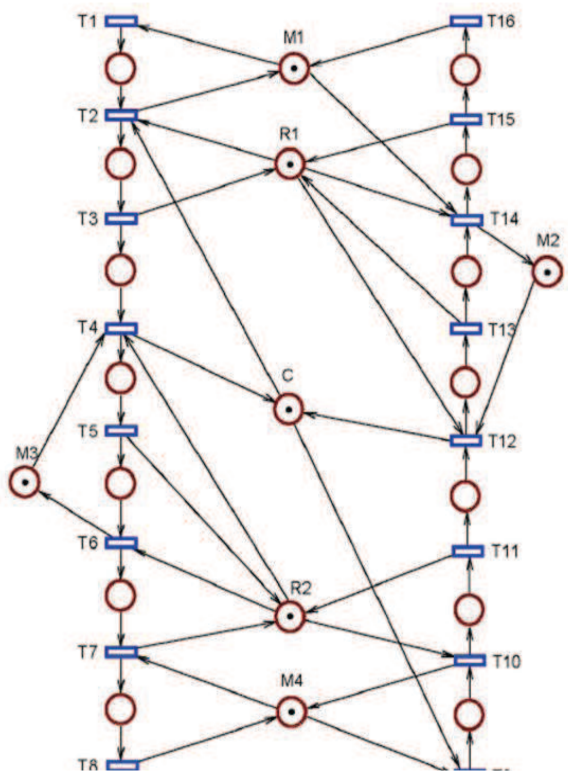

Fig 7

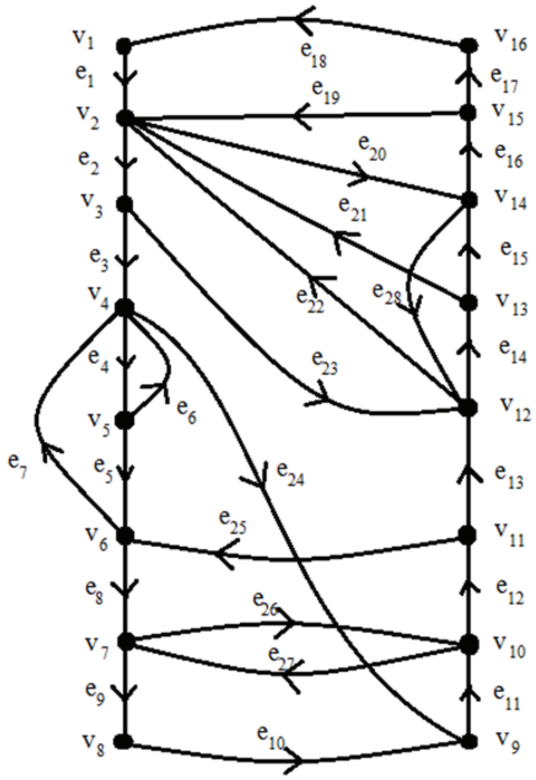

Fig 8

Conclusion: In this paper we have taken three Petri net models of non-deadlock free FMS and a FMS with Four machines and two robots and converted them into Digraphs by the method suggested in [4].We found that except the last one all are Euler digraphs. In [5] and [6] one also the same conversion according to [4] applied and [5] the result was Euler digraph and in [6] it was not.

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