RESEARCH COMMUNICATION

DEADLOCK PREDICTION AND AVOIDANCE IN AN AGV SYSTEM

Ram Pratap Yadav
Research Scholar, Department of Mechanical Engineering,
MMM Engineering College, Gorakhpur, Uttar Pradesh, INDIA.
E-mail: rampratap86@gmail.com.

ABSTRACT

The main purpose of this project is trying to understand where current technology could lead literal way. The subject of this thesis is to build up an Automatic Guided Vehicle to development of algorithm for deadlock prediction & avoidance in an AGV system. Deadlock in a broad sense is a situation in which at least a part of the system stalls. Automated Guided Vehicle (AGV) systems offer flexibility and automation required by Flexible Manufacturing Systems (FMS). Previous research on AGV systems mainly focuses on the performance of the task completion time and the AGV operation in dispatching and routing.

Keywords: Material Handling System, AGV System, Modeling and Simulation, Routing Flexibility.

1. INTRODUCTION

AGV are automated vehicles whose movement are controlled by a central or distributed control system. Automated guided vehicles (AGVs) constitute a major component of many automated material handling systems. AGVs are driverless vehicles that follow physical or virtual guide paths under the control of a computer. Such vehicles play a key role in interconnecting all important locations on the factory floor for the horizontal movement of materials in a flexible manner...

1.1 The AGV Application

An AGV system is a fully automated industrial transport system that uses multiple AGVs to transport loads (raw materials, finished products, etc.) in an industrial environment such as a warehouse. In this section we give a brief overview of the AGV application. Subsequently we describe the map of the environment, the transports, and the AGV time, etc.

1.2 AGV

Material handling in manufacturing systems is becoming easier as the automated machine technology is improved. Today’s rapid development in technology presents manufacturing firms a variety of alternatives for in-plant transportation. An Automated Guided Vehicle (AGV) system is such an advanced material handling system that involves a fleet of driverless vehicles (AGV) which follow a guided path and are controlled by a computer (Hammond, 1986).

2. LITERATURE REVIEW

Deadlock detection has been a very important research topic and there are quite a few papers written in this field. But most of these literatures are suitable for very simple or small AGV layout. Lee and Lin use the theory of Petri-nets on AGV systems. They extended the idea of using Petri-nets on flexible manufacturing systems (FMS) proposed by Viswanadham, Narahari and Johnson for deadlock prediction and avoidance. In this paper, there is no mention of actual implementation of the algorithm. The complexity of this method is $O(nm^2)$ where ‘n’ is the number of nodes and ‘m’ is the number of arcs.

Fig. 1.0 : Used in Industry of AGV

3. DEADLOCK PREDICTION ALGORITHMS

A system is said to be in a deadlock if a part or the whole of the system stalls. In the AGV, resources (zones between control points) are shared among the whole population of vehicles. Each of the vehicles can only occupy one zone at a time. The necessary conditions leading to deadlock, the different types of deadlock that can be deduced from the routing policy of the AGV and the deadlock prediction and avoidance measures taken will be touched.
The resources mentioned in the four conditions refer to the zones of the path and the processes are the AGV’s. Mutual exclusion is obvious, since a zone cannot have two vehicles in it at any given time. This is a condition required by the control system in order to prevent the AGV’s from colliding into each other. ‘No Preemption’ is also obvious because, the vehicle must be in any zone at a given time (it cannot disappear into thin air) and the movement of the vehicle into another zone satisfies the condition. As for ‘Hold and Wait’ condition, it is also satisfied in the case of the AGVS as each vehicle has to zone at any one time and is waiting to move into its designated next zone. Thus all of the first conditions are satisfied leaving only the ‘circular wait’ condition. This condition is not always true in the AGVS and this is where the deadlock prediction can be used to detect whether a deadlock is imminent.

3.1 Mutual Exclusion
Two or more processes cannot use a resource at a time.

3.2 No Pre-emption
When a resource is being used, it is not released until the process using it finishes with it.

3.3 Hold and Wait
A process that is holding at least one resource and is waiting to acquire additional resources that are currently being seized by other processes.

3.4 Circular Waits
A closed chain of processes in which each process is waiting for a resource occupied by the next process in the chain.

4. DEADLOCK PREDICTION ALGORITHMS
The following is the definition of the numbers in Fig3.0

1. Extract the location (Lp) (i.e. the control points) of its next zone of the selected Vehicle (say Vi) that is about to enter a new zone. For every sampling time i.e. 1.5 Sec to 2 sec, a check is done to see if a vehicle has moved to a new zone or not. If it has, the vehicle is selected so that a deadlock prediction for its next zone step is done.

2. Check whether this next zone (Lp) is occupied by another vehicle.

3. Extract the location (Lq) of Vi’s next 2 zone (i.e. the “next next” zone).

4. Check whether any other vehicle occupies Lq.

5. Extract next zone location (Lr) of the vehicle that is occupying Lq and update Lq to the location Lr.

6. Return “vehicle is blocked”.

7. Return “vehicle is safe to proceed, deadlock is not predicted.

8. Check whether Lp is equal to Lq.

9. Return “vehicle is not safe to proceed, deadlock is predicted.”
There is not much literature available on dynamic updating of arc weights on large networks and hence, we have devised a computationally cheap method for doing the above operation. The figure 3.1 is a simple sketch of the method in which the arc weights are updated. The figure represents the path that a vehicle is originally assigned to and also due to prediction of deadlock; the route has been changed as shown in 3.1 above.

5. DEADLOCK AVOIDANCE
There are two strategies used as an avoidance measure: ‘Wait and proceed’ and ‘rerouting’. The following is a brief description of both the avoidance strategies.

4.1 Wait and Proceed
In this strategy, when a vehicle predicts a deadlock in its route, then the vehicle stops at the same location and waits until at least one vehicle gets cleared from the Predicted deadlock region.

4.2 Rerouting
Another way of avoiding deadlock is by using a dynamic routing system. The system proposed is not entirely dynamic due to the time constraints i.e. the decision of rerouting and the new routes are to be given back to the control system within 2 seconds. Hence, a semi-dynamic routing strategy that computes static routes taking into consideration the traffic congestion effects is proposed as a solution to the avoidance problem.

6. CONCLUSION
We have also developed efficient AGV routing algorithms with the help of the simulations.

In this paper we investigated how single AGV controllers can be extended such that multiple AGVs can transport a common load in cooperation with each other. We focused on the situation that the load is rigidly or semi-rigidly attached to the vehicles, e.g. by means of completely rigid interconnections, revolute joints, or slider joints. Furthermore, attention was restricted to control on the velocity level, which we regard as an intermediate step for achieving fully automatic operation. In our setup the motion set point is provided by an external host. The load is assumed to be already present on the vehicles.

7. SCOPE AND FUTURE WORK
1. Also optimized the algorithm for deadlock prediction
2. The same work can do for other system.
3. The control strategy parameters could be optimized to achieve the demanded performance of today’s conventional vehicles.

7. REFERENCES

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