Chapter 14
Inbound Logistics and Vehicle Routing

Reza Zanjirani Farahani
Kingston University, UK

Hannaneh Rashidi-Bajgan
Islamic Azad University, Iran

Taravatsadat Nehzati
University Putra Malaysia, Malaysia

ABSTRACT

One of the most important factors in the design of automated guided vehicle system (AGVS) is the flow path design. The unidirectional/conventional flow path design in automated guided vehicle (AGV) routing problem considers aisles to be undirected so that each pair of cells could be reached mutually. Regarding the flow between cells, this chapter presents a novel algorithm to minimize the total distance traveled by the loaded vehicles on the block layout graph. The algorithm is an efficient branch-and-bound method with branches on the feasible solutions to solve the strongly connected graph layout. To find the feasible and efficient flow path, the authors use the Revised-DFS based on testing connectivity of the graph.

INTRODUCTION

An AGV is a driverless vehicle used for transferring goods and materials on the guide-path of the floor (Hodgson et al., 1987). Since, successfully utilizing an AGVS is depended on efficient material flow, designing guide-path layout is among the most important factors in this problem. Choosing appropriate vehicle type(s) is another important factor. Muckstadt (1982) faced with the issues of vehicle routing problem with minimum number of vehicles. They considered the number of trips over each route and the vehicles routs to design the material handling system simultaneously. This work was followed by Leung, et al. (1987), who supposed dynamic mode for the capacity and speed of the vehicles. Shelton and Jones (1987) developed a model to meet the requirements of the system by providing a set of AGVs. Some other algorithms assumed the predetermined

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number of vehicles and the flow path. For example, in assuming a given number of vehicles and the flow path, Blair, et al. (1987) proposed a heuristic algorithm to organize material movement with selecting the minimum of maximum tour lengths. Another efficient factor to design material flow could be dispatching. Egbelu and Tanchoco (1984) presented and evaluated the effectiveness of a number of heuristic rules for dispatching AGVS in different job shop environments by using simulation. A system controller could regulate traffic when more than one vehicle is in the system.


This chapter considers conventional flow path, which restricts vehicles to travel on only one direction along a given segment of the flow path, and this is called unidirectional configuration. Usually in unidirectional travel, vehicles have to travel a greater distance rather than bi-directional flow path. On the other hand, unidirectional flow requires less control and is more economical. The objective of conventional flow path wishes to minimize the total traveled distance by the loaded vehicles subject to the constraint that result to a single strongly connected component as the network of routing.

First, Gaskin and Tanchoco (1987) proposed conventional systems. As the first work to determine the optimal unidirectional flow path, they developed a method using zero-one integer programming. This method contains a nonlinear objective function to minimize the total traveled distance, and many sets of constraints. The constraints require evaluation of various shortest paths from the pickup to delivery point. In a follow up paper, Kaspi and Tanchoco (1990) considered a branch-and-bound technique for solving the same problem. Venkataramanan and Wilson (1991) presented an algorithm for determining the optimal unidirectional flow path for an AGVS on a given facility layout. The problem was formulated as an integer programming model, which minimizes the total traveled distance by vehicle subject to the constraints lead to a single strongly connected component. They discussed a special branch-and-bound procedure to face with the problem. In last three papers, the pickup/delivery (P/D) stations were assumed stationary. Farahani and Tari (2001) presented a branch and bound algorithm like Venkataman and Wilson’s (1991), whilst Farahani and Tari (2001) applied some additional properties to determine the optimal flow-path in the conventional frame. Kim, et al. (2000) utilized pair-wise interchanges besides simulated annealing method to address determining the locations of P/D stations in an AGVS. Seo, et al. (2003) supposed a tabu search method to reach near optimal solutions for unidirectional flow path design of AGVS. Kim and Goetschalckx (2005) developed an approach to determine the block layout, shortest path, and the input/output point locations, simultaneously. Their method was embedded into a simulated annealing algorithm to obtain a high-quality layout design based on the contour distances. More recently, Sedhi and Farahani (2009) demonstrated an algorithm for