ROUTING AND DISPATCHING AUTOMATED GUIDED VEHICLES USING GENETIC ALGORITHM

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The type of material handling systems that are used in a firm determines the layouts of most of the manufacturing firms. The layouts are normally designed to facilitate easy handling and to increase the utility of the material handling systems. Automated guided vehicles (AGVs) are flexible automated material handling systems that can be programmed to follow any route to reach a designated callstation. As the equipment cost of AGV is high, the utility has to be increased. In case of multiple callstations with one AGV to attend all the stations, an appropriate dispatching strategy has to be used to increase the utility of the AGV [1,2]. In this paper, different dispatching strategies like first in first serve (FIFS), random call stations, and random call stations with priority stations are simulated. The proposed simulation model can handle any arbitrary system layout with any number of stations that are catered by one bidirectional AGV.

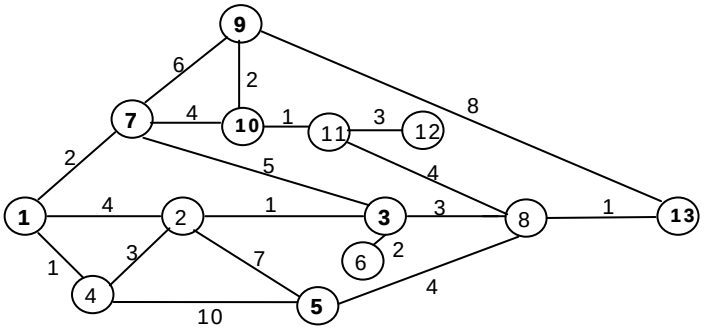

Fig 1. A Typical Layout

Table 1. Alternate Routes From Station *1* To Station *13*

S.No.	Routes	Distances
1.	**1**,2,3,8,**13**	**9**
2.	**1**,4,5,8,**13**	16
3.	**1**,4,5,2,3,8,**13**	23
4.	**1**,7,9,**13**	16
5.	**1**,7,10,11,8,**13**	12
6.	**1**,7,3,8,**13**	11
...	...	...

The inputs to the computer simulation model are the total number of stations, distances between the nearest stations that have direct connectivity, the starting station and the series of callstations. The present AGV position is considered as the starting station. A typical layout with 13 stations along with the distances between consecutive stations is shown in Fig 1. In FIFS dispatching, the callstations are attended by first in first serve. Consider the AGV is at station *1* and the callstations are *13, 9, 3, 5, 7* and *10*. There are many routes to follow from *1* to *13*, as shown in Table 1. The distance of each route is calculated and the route with the shortest distance is identified (in this case, *1,2,3,8,13*). Similarly, the shortest distance route for the subsequent callstations is identified and the final route along with the total distance is given as the output as shown in the Table 2.

The random callstation dispatching is performed using genetic algorithm. This type of dispatching can be used when any dispatching order can be followed among the callstations. The objective is to minimize the total distance travelled by the AGV. The population size is taken two times the size of the total callstations. A roulette wheel selection procedure is adopted and the probability of crossover and mutation are taken as 0.8 and 0.15 respectively [3]. A two-point crossover with randomly selected crossing sites and a pair wise mutation is used. Typical crossover and mutation procedures employed are as shown in Fig. 2. In order to emphasize better solutions in each generation and to avoid losing better solutions in the subsequent generations, elitism is employed. Elitism is done by transferring the best two dispatching orders from the previous generation to the next generation as such, without performing any crossover and mutation. Convergence is obtained when the total distance for the best dispatching order in consecutive five generations are the same. The difference between FIFS and random order dispatching is that in FIFS, the dispatching order is predefined and only the intermediate routes with shortest distances are identified. In random order dispatching, the dispatching order as

well as the intermediate routes with shortest distances that will lead to minimum total distance is identified. The optimal dispatching order and the route for a typical set of callstations is given in Table 2.

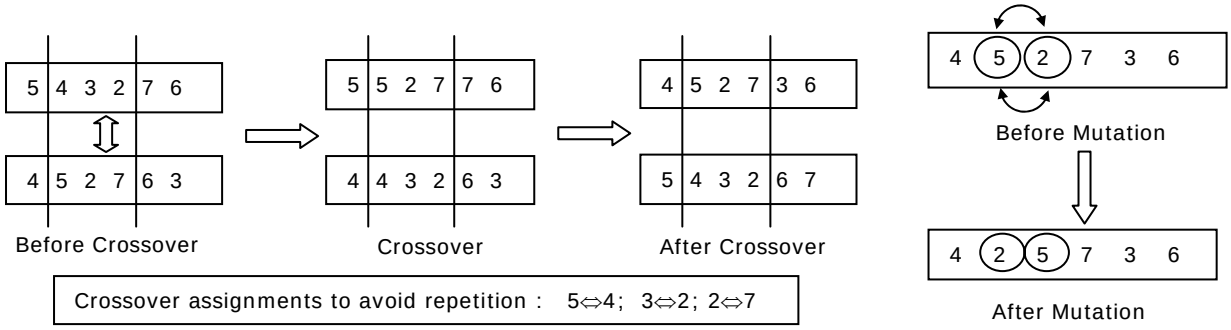

Fig 2. Crossover And Mutation Procedure

The random callstation with priority stations dispatching can be used when only a few callstations have priority among the total callstations. In this type, the callstations having priority are first served by FIFS and the remaining callstations are served as random callstation dispatching. The dispatching order and the route for a typical set of callstations obtained in this method is given in Table 2.

Table 2. Results Obtained For A Typical Set Of Callstations

First In First Serve (FIFS) Call stations : 13, 9, 3, 5, 7, 10 Dispatching Order : 13, 9, 3, 5, 7, 10			**Random Callstation** Call stations : 13, 9, 3, 5, 7, 10 Dispatching Order : 7, 10, 9, 13, 3, 5			**Random Callstation with priority stations** Call stations : 13, **9**, 3, **5**, 7, **10** Dispatching Order : **9**, **5**, **10**, 7, 3, 13		
Stations	Shortest Routes	D	Stations	Shortest Routes	D	Stations	Shortest Routes	D
1 to 13	**1**,2,3,8,**13**	9	1 to 7	**1,7**	2	1 to 9	**1**,7,**9**	8
13 to 9	**13**,8,11,10,**9**	8	7 to 10	**7,10**	4	9 to 5	**9**,10,11,8,**5**	11
9 to 3	**9**,10,11,8,**3**	10	10 to 9	**10,9**	2	5 to 10	**5,**8,11,**10**	9
3 to 5	**3**,8,**5**	7	9 to 13	**9**,10,11,8,**13**	8	10 to 7	**10,7**	4
5 to 7	**5**,8,3,**7**	12	13 to 3	**13**,8,**3**	4	7 to 3	**7,3**	5
7 to 10	**7**,**10**	4	3 to 5	**3,**8,**5**	7	3 to 13	**3,**8,**13**	4
The total distance is :		50	The total distance is :		27	The total distance is :		41
(D – Distance)								

The computer simulation is developed using “C”. Different layouts with different sets of callstations are simulated. Simulation models for routing and dispatching with multiple AGVs is under development.

References :

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3. Kalyanmay Deb “ Optimization for Engineering Design”, Prentice Hall Publications.