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SCHEDULING OF AUTOMATED GUIDED VEHICLE IN DIFFERENT FLEXIBLE MANUFACTURING SYSTEM ENVIRONMENT

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Abstract- Automated Guided Vehicles (AGVs) are among various advanced material handling devices that are finding increasing applications today. AGVs can be interfaced to various other production and storage equipment and controlled through an intelligent computer control system. In this paper, scheduling of job is done for a particular type of FMS environment by using an optimization technique called the genetic algorithm (GA). MATLAB software is used for the particular scheduling of AGV to get optimum solution. The coding of GA is done on MATLAB. When a chromosome is input, the GA works upon it and produces same number of off springs. The number of iterations takes place until the optimum solution is obtained. For the usefulness of the proposed system, seven case studies are demonstrated. The input parameters (number of jobs, number of machines and number of AGVs) used are Travel Time matrix and Processing Time matrix with the number of machines and number of jobs.

Keyword: Automated guided vehicle, Flexible manufacturing system, Genetic algorithm, scheduling

I. INTRODUCTION

Automated Guided Vehicles (AGV) are computer-controlled “driverless” mobile vehicles (normally battery operated) equipped with optical, magnetic or laser guidance systems for automated functionality, categorized as either load carrying (forked, mandrel, unit load deck, etc.) or load towing.(David, 2005). Automated Guided Vehicles are recommended for applications where in long-distance horizontal transport of materials is required from or to multiple destination points and/or the requirements for material transport include repetitive/predictable and/or dangerous tasks. AGVs also have several advantages inherent to their design, such as the reduction of product damage from removal of human error, the ability to travel into hazardous areas without concern for operator safety, the ability to automatically track and record product movement, the reduction of labour, and the flexibility and adaptability especially prevalent in laser guided systems.

II. OBJECTIVES FOR SCHEDULING OF AGV

In the paper aim is developing scheduling system for AGV in different FMS environment. Various steps involved in the development of the proposed system are processing time, travelling time, operation completion time, job completion time and minimization of makespan of the scheduling of AGV. For the development of the proposed system, the first activity is to develop MATLAB code for processing time, travelling time, operation completion time, job completion time. This code is capable to check how much time AGV take to reach one station to another station. Thereafter, the MATLAB code is to develop for job based representation. This code is capable to check the sequence of the operation at machine. Finally, the MATLAB code is developing for genetic algorithm. This code is capable to check in which chromosome sequence the AGV take minimum time for the scheduling and Gantt chart for the minimum time of operation. An objective of this paper work is given below:

1. To find the processing time for AGV.
2. To find the travelling time for AGV.
3. To find the operation completion time for AGV.
4. To find the job completion time for AGV.
5. To develop MATLAB code for find the minimization of makespan of the scheduling of AGV.

III. METHODOLOGY

Representation of operations of a job

The representation is explained considering an example with 4 machines and 3 jobs. Job1 consists of 3 operations, job 2 consists of 2 operations and job 3 consists of 2 operations. Total there are 7 operations and 1 represents 1st operation of first job, 4 represents first operation of 2nd job and so on. The procedure constraints in a job shop are crucial and cannot violate; hence necessary care is taken during the operation schedule generation itself.

Table I-Job sequence of the FMS (Reddy et al. 2011)

No. of job	1			2		3	
Operations on each job	1	2	3	1	2	1	2
Machines	M_1	M_3	M_4	M_2	M_4	M_3	M_1
Representation(chromosome)	1	2	3	4	5	6	7

Genetic Algorithm Procedure for scheduling of AGV

Jobs are scheduled based on the operation sequence derived by the GA. Initially, AGVs carry jobs from the load/unload station to the respective workstations where the first operations are scheduled. First schedule the operations according to the chromosome sequence, and then find which AGV will reach the L/U station or the machine with demand point early. Move the AGV from the current point to request point for its next assignment. Wait for the AGV until the job is ready if there is no job ready. Move the job to the machine at which the next operation is scheduled. If the machine is busy, AGV drops the job at the machine buffer; job will be loaded after the machine becomes free. Load the job on the machine if the machine was free. Check if all the operation is completed and the scheduling is finished; otherwise find which AGV will reach L/U station or the machine with demand point early. The following steps need to be done during the simultaneous scheduling of machines and AGVs:

1. Schedule the operations according to the sequenced string.
2. Find which AGV reaches the L/U station or the machine with demand point earlier.
3. Move the AGV from the current point to request point for its next assignment.
4. Wait the AGV until the job is ready if there is no job ready.
5. Move the job to the machine at which the next operation is scheduled.
6. If the machine is busy, AGV drops the job at the machine buffer; job will be loaded after the machine becomes free.
7. Load the job on the machine if the machine was free.
8. Check if all the operation is completed.

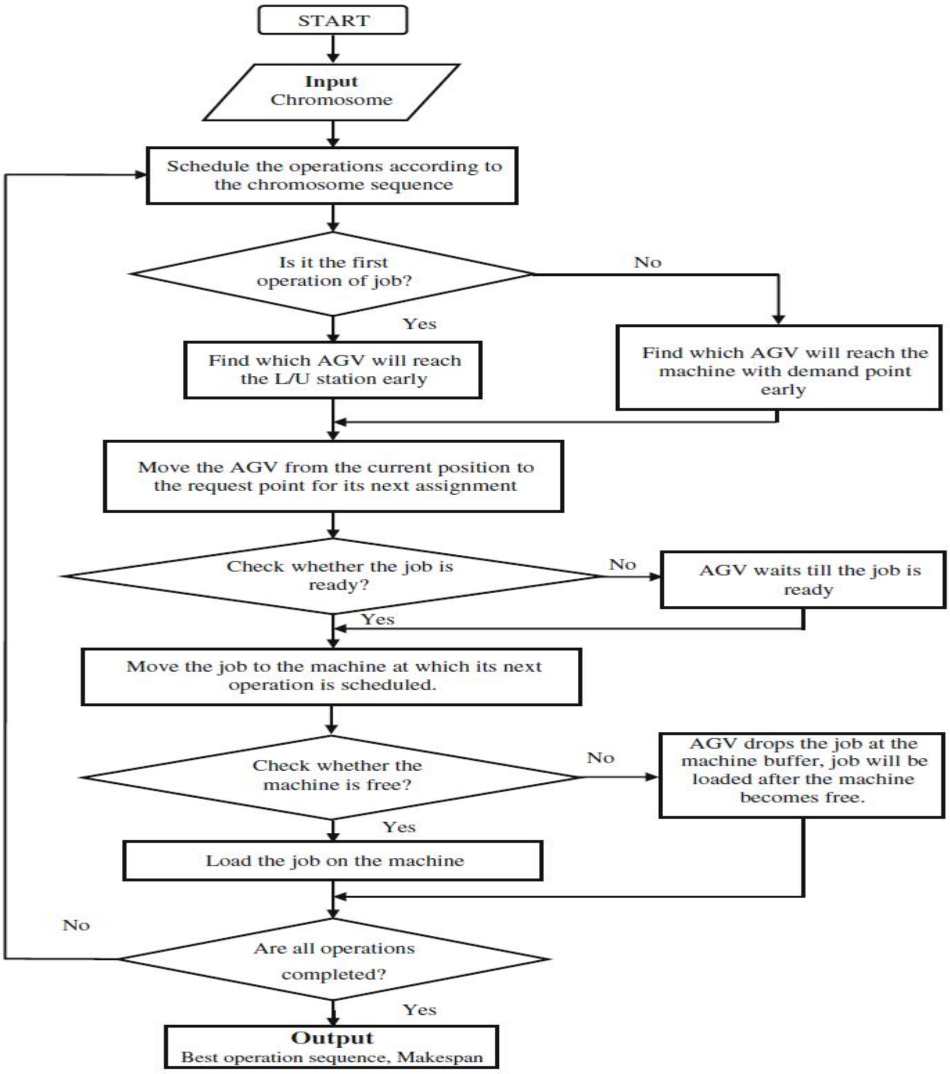

Fig 1 Framework of the scheduling of AGV

IV. CASE STUDY

The FMS layout along with the distances between the machines and from the load/unload station are all shown for different problems. The FMS consists of given number of machines and 2 AGVs. The job set details are also given. AGV move with a speed of 40 m/min and the loading and unloading times of job are 0.5 min each. The travel times are computed and are presented in Table, in which the loading and unloading times of the job are included.

Objective Criteria: Minimization of makespan.

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GA Parameters: Population size=300,
Archive size=300,
Probability of crossover=0.6,
Probability of mutation=0.4,
Number of generations=100.

The FMS layout consist six machines (M1, M2, M3, M4, M5, M6), six jobs and two AGVs. In the figure 2 the routes of AGVs are given.

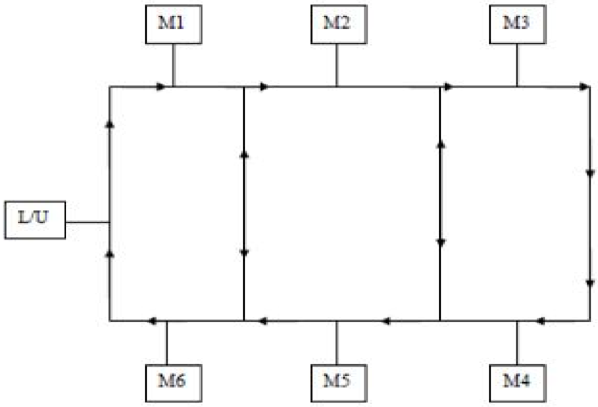

Fig 2: FMS layout of case study 1(Reddy et al, 2006)

Table II-Travel Time matrix (T_{ij}) (Tiwari, 2010)

	L/U	M1	M2	M3	M4	M5	M6
L/U	0	4	6	8	14	12	10
M1	10	0	3	5	11	9	7
M2	12	15	0	3	9	7	9
M3	14	17	15	0	7	9	11
M4	8	11	9	7	0	3	5
M5	6	9	7	9	15	0	3
M6	4	7	9	11	17	15	0

Table III- Processing Time Matrix (P_{ij}) (Tiwari, 2010)

Job No.	M/C	PT	M/C	PT	M/C	PT	M/C	PT	M/C	PT	M/C	PT
1	1	3	2	6	3	1	4	7	5	6	6	3
2	1	10	2	8	3	5	4	4	5	10	6	10
3	1	9	2	1	3	5	4	4	5	7	6	8
4	1	5	2	5	3	5	4	3	5	8	6	9
5	1	3	2	3	3	9	4	1	5	5	6	4
6	1	10	2	3	3	1	4	3	5	4	6	9

Table V- Job completion time (C_j)

M/C	M1	M2	M3	M4	M5	M6
M1	7	10	5	11	10	7
M2	14	12	9	8	14	14
M3	13	5	9	8	11	12
M4	9	9	9	7	12	13
M5	7	7	13	5	9	8
M6	14	7	5	7	8	13

According to the tables 2,3,4 processing time matrix shows the how much time AGV to take pickup and release the job, travelling time matrix shows the how much time AGV to take travel one machine to another machine and job completion matrix shows the addition of processing and travelling time of AGV.

Sequence of the process:

Chromosome is 1 3 5 6 4 2

Makespan Time is: 121mins

V. Result and discussion

In this paper work, seven case studies were taken from various literatures. The output of developed system is summarized in Table 5.

Table 5: comparison of the results

Problem no	No of machines	No of jobs	Results of job based method makespan	Results of operation based method makespan(Tiwari, 2010)
1	6	6	121	116
2	4	4	83	104
3	4	4	61	86
4	5	5	88	133
5	5	5	90	93
6	5	5	81	139
7	6	6	135	129

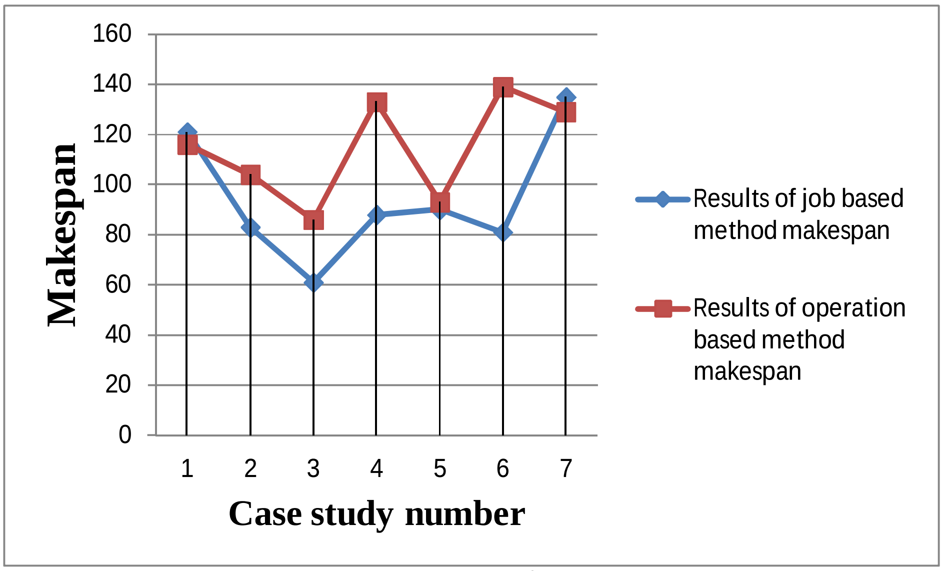

Fig 2 Comparison of results

VI. CONCLUSION AND FUTURE WORK

In this paper work, the simultaneous scheduling of machines and AGVs in FMS are addressed using GA for the minimization of makespan. The FMS layouts are solved by the genetic algorithm. The coding of proposed system is done using MATLAB software. The results obtained from these case studies are quite similar to the operation based method.

In most of the case studies are found to be converged within 100 generations for a crossover and mutation probabilities of 0.6 and 0.4, respectively. When changing the probability of crossover and mutation the number of generation is increases then sequence of chromosomes are repeated.

The similar approach can also be used to solve by other techniques such as particle Swarm Optimization, adaptive Genetic Algorithm, Ant bee colony, mimetic algorithm. It can be also solved by different coding languages. Like VB (Virtual basic), C, C^{++}.

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