International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 – 5161

Available at http://inpressco.com/category/ijcet

Research Article

A Simulation modelling of scheduling of automated guided vehicle in flexible manufacturing system environment

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Received 20 Dec 2020, Accepted 25 Feb 2021, Available online 27 Feb 2021, **Vol.11, No.1 (Jan/Feb 2021)**

Abstract

Automated Guided Vehicles (AGVs) are among the fastest and advanced material handling technology that are utilized in various industrial applications today. They can be overlapped to various other manufacturing and storage system and controlled through an advanced computer control system. Flexible Manufacturing systems (FMS) are compatible for concurrent manufacturing of a good sort of parts in low quantity. The Flexible Manufacturing systems elements can operate in a non parallel manner and the scheduling problems are harder. The use of AGVs is increasing day by day for the fabric movement in production lines of flexible manufacturing plants. The purpose is to extend efficiency in material transfer and increase manufacturing. Though the hardware of Automated Guided Vehicle has made remarkable enhancement in the field but the software control of the speed still lacks in many applications. The order of scheduling of operations on machine centers as well as the scheduling of Automated Guided Vehicles are important factors contributing to the overall efficiency of flexible manufacturing system (FMS). In this work, scheduling of job is done for a particular type of flexible manufacturing system (FMS) environment by using the technique of optimization called the genetic algorithm (GA). A code was developed to seek out the optimal solution and generate random values in Ms-Excel. When a chromosome is input, the GA works upon it and produces same number of offspring's. The number of iterations takes place until the optimum solution is obtained. Here we've worked upon eight problems, with different no. of machines and no. of jobs. The input parameters used are time period matrix and time interval matrix with the amount of machines and number of jobs. The results obtained are very quite close to the results obtained by other techniques and by other scholars.

Keywords: *Automated Guided Vehicles, loading point, delivering point, make span time, genetic algorithm, flexible manufacturing system, time travel matrix, problem time matrix, chromosome*

1. Introduction

The principal objectives of present's automation technology are flexibility and productivity, which can only be attained in complete integrated manufacturing ambience. In this essential integration a conscientiously designed and sensibly arrange material handling system is of importance. Automated guided vehicles (AGVs) are among the fastest increasing classes of object within the material handling enterprise. They are computer-controlled "driverless" mobile vehicles having capabilities for positioning and path selection. They are proficient of responding quickly to frequently changing transport model. Automated guided vehicles (AGVs) are often merging too many other storage, production equipment and may be controlled through an integrated computer system . The requirement is to extend efficiency of production and material transfer.

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DOI: https://doi.org/10.14741/ijcet/v.11.1.9

However, while the hardware of AGVs has upgraded continuously, but the software of AGVs remains lack in many respects.

On the one hand there is requirement for discovering ideal track between groups of loading and unloading units or sources and receivers. The most important demand of an AGV technology is the transfer of materials from a set of loading units to a set of unloading units. As in the case of processing components of machine unit in a serial manner the source unit and destination units may be from the common pool of units. Otherwise they can be specific e.g. raw materials are fed through source units, and raw materials are received at destination units for complete machining. Loading point (LP) is a station through which all the raw materials are fed. This point serves as the permanent source in our material transfer problem. The numbers of machining units are used for material transfers who assist as the delivery points(DP).

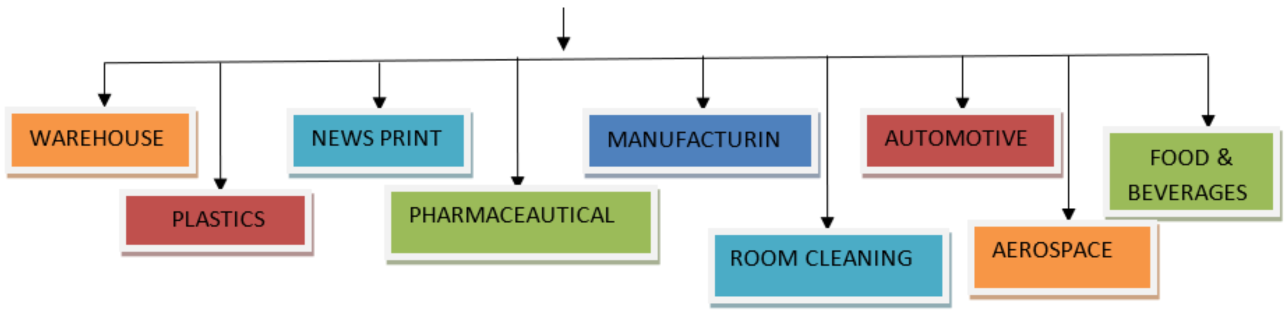
The area of operation of our AGVs is physically disjoint with the processed materials from these machining units are output to separate AGV system. In other words, we are only influenced about the distribution of raw materials from loading point (LPs) to varied delivery point (DPs) during a way that results in best use of the machining units and therefore the automated guided vehicles (AGVs). In material transportation problem, the paths from Loading point (LPs) to Delivery point (DPs) are stick out sort of a tree with the loading points (LPs) at the basis and delivery point (DPs) on the branches. Because there are not any closed loops, there are not any options about moving from the loading point (LPs) to any of the delivery point (DPs), or from one delivery point (DP) to another delivery point. So the routing problem is extremely much solved during this case. We know the stock position of every delivery Point (DPs) at any point of your time. We have the info about average consumption rates of materials at each delivery Point (DPs) from sensors mounted on the conveyors; we assume a specific load potential of the automated guided vehicles (AGVs). In material transportation problem, the paths from Loading point (LPs) to delivery automated guided vehicles (AGV).

2. Objective of thesis

Our aim in examine an automated guided vehicle (AGVs) based flexible material distribution system which fits to application in the following manner:

(1) Find out how many minimum numbers of automated guided vehicles (AGVs) will be essential to meet the entire material distribution requirement.
(2) Suggest and judge miscellaneous dispatch rules for appointed transfer jobs to the automated guided vehicles (AGVs). We input framework that prepare us to correlate acting of other dispatch rules in status of fabric throughput and evenness of distribution over the delivery points (DPs).
(3) Then a pattern is reserved for partitioning out the entire area into special zones, one for every automated guided vehicle (AGV) — to trim the trail among automated guided vehicles (AGVs) and thus avoid difficulties arising out of that.
Here a try has been made to consider together the vehicle and machine scheduling aspects in a Flexible manufacturing system (FMS) and address the issue for the minimization of make span time (Ms).

1.1 Applications of AGVs in the following fields



3. Literature Review

Most of the previous works address the machine and vehicle scheduling as two liberated problems. However, only some had given priority to the scheduling of machines and vehicles at the same time. The high expense required for FMS and the potential of FMS as a crucial competitive tool make it an appealing research subject. Hence, a number of ways and process are tested for scheduling of FMS has been extensively examined over five decades and it carries to draw the interest of both the industrial and academic sectors. Different types of scheduling problems are being solved in various environments of job shop. Different types of many algorithms are used to find near optimal schedules. Conventionally, the automatic generation of scheduling plans for job shops has been addressed using optimization and closeness way. Two basic ways to this same problem are real-time scheduling and off-line scheduling. Both aspects are examined by several researchers. Fleming and Fonseca proposed a multi-objective genetic algorithm (MOGA).

Their approach consists of designs in which the number of individuals corresponds to the rank of an individual by which it is governed. Based on suggestions gave by Srinivas, Goldberg's, and Deb developed an approach which was called (NSGA) non-dominated sorting genetic algorithm. These non-dominated solutions of a front are accredit the identical mannequin fitness value and are shared with their own mannequin fitness values and ignored in the further classification process. Finally, the mannequin fitness is set to a specific value less than the smallest shared fitness value in the common one of the non-dominated front. Then until all the alternatives in the population are classified the next front is extracted and the repeated. Wysk and Wu, Kim and Ro, Hommertzheim and Sabuncuo~lu , and Sawik develop control rules and on-line dispatching for AGVs and machines. Han and McGinnis treat with a special case of material handling transporter in a real time environment. Taghaboni and Tanchoco for free-ranging AGVs developed an intelligent real-time controller. Tanchoco and Co for multiple-load AGVs introduce real-time control strategies. Karabtik and Sabuncuo~lu for the simultaneous introduce a beam search based algorithm scheduling of AGVs and machines Raman etal develops a deterministic off-line scheduling model developed as an integer programming difficulties and a solution procedure is presented based on concepts of assignment scheduling under resource confinement. Their assumption that flexibility of AGV and its influence on the schedule are reduces due to vehicles always return to the unload/load station after transferring a load. The simultaneous job input sequence and also vehicle dispatching for a single AGV system was addressed by Lacomme et al. Schaffer has presented a multi-modal EA called (VEGA) vector evaluated genetic algorithm, which carries out selections for each objective individually. An approximated approach based on this sum secularization was introduced by Hajela and Lin to search for multiple solutions in parallel FMS with parallel identical machines arranged in a loop was considered by Blazewicz etal Palekar and Pandit present a number of alternatives of a shifting bottleneck heuristic for minimizing make span with a single vehicle. Another off-line model for minimization of make span is presented by Ulusoy and Bilge who determines the problem for multiple AGVs. As a mixed integer programming problem they formulate the problem. In this formulation the AGVs after each delivery don't have to return to the unload/load station which increases the complexity of the problem. The overall problem is break down into two sub problems, and a repetitive solution procedure is developed. Nagi and Anwar addressed the concurrent scheduling of trip-based material handling system and machines in just in time (JIT) environment. Corne and Knowles developed a way called Pareto archived evolution strategy (PAES) that incorporates theory. In their approach, non dominance comparison was made between a child and the parent. Horn et al. proposed the Niched Pareto GA that integrates concept of Pareto dominance and the tournament selection. Thiele and Zitzler maintained an external archive which store all the non-dominated solutions found at every generation from the beginning by proposing the theory of strength pareto evolutionary algorithm (SPEA). Abdelmaguidetal has presented a new hybrid genetic algorithm for the make span minimization objective of scheduling problem. The Hybrid Genetic Algorithm is consisting of GA and a heuristic. Genetic Algorithm (GA) is used to address the first part of the problem that is theoretically similar to the vehicle assignment algorithm (VAA) which is handled by a heuristic called vehicle assignment algorithm (VAA) and the job shop scheduling problem.

Objective of problem 1: To Minimize the make span.
GA Parameters for problem 1: Initial population size =4,
Probability of crossover=0.6,
Probability of mutation=0.01,
Number of generation=100

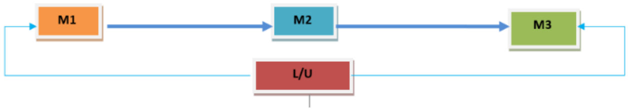


Fig. Problem 1 FMS Layout

Number of machines: 03
Number of jobs: 03

Table 1 Travel time matrix

	L/U	M1	M2	M3
L/U	0	2	4	10
M1	12	0	2	8
M2	10	12	0	6
M3	4	6	8	0

Table 2 Process time matrix

Job No.	Job1		Job2		Job3	
Machine	M1	M3	M1	M2	M3	M2
Operation Number	1	2	3	4	5	6

Table 3 Data for job set matrix

Job	M1	M2	M3
1	8	16	12
2	20	10	18
3	12	8	15

Calculation

In GA genetic algorithm sequence of operation is generated which is the initial population. Let the initial population of 4 sequences A, B, C, D is given in input.

Initial population for problem 1

A	1	2	3	4	5	6
B	6	5	4	3	2	1
C	4	3	6	2	1	5
D	3	4	2	5	6	1

Calculation of make span time (Ms for the chromosome A, B, C, D.)

For Chromosome A: - 1 2 3 4 5 6

Operation1:
Time transfer the work from L/U to machine 1 + Process time of job 1 on machine 1 is 2 + 8 = 10.

Operation 2:
Time transfer the work from machine 1 to machine 3 + Process time of job 1 on machine 3 is 8 + 16 = 24.

Operation 3:
Time transfer the work from machine 3 to machine 1 + Process time of job 2 on machine 1 is 6 + 20 = 26.

Operation 4:
Time transfer the job from machine 1 to machine 2 + Process time of job 2 on machine 2 is 2 + 10 =12.

Operation 5:
Time transfer the work from machine 2 to machine 3 + Process time of job 3 on machine 3 is 6 + 15 = 21.

Operation 6:
Time transfer the work from machine 3 to machine 2 + Process time of job 3 on machine 2 is 8 + 8 = 16.

Total make span time Ms for Chromosome A is = 10+24+26+12+21+16 = 109.

For Chromosome B: - 6 5 4 3 2 1
Operation 6:
Time transfer the work from L/U to machine 2 + Process time of job 3 on machine 24 + 8 = 12.

Operation 5:
Time transfer the work from machine 2 to machine 3 + Process time of job 3 on machine 3is 6 + 15 = 21.

Operation 4:
Time transfer the job from machine 3 to machine 2 + Process time of job 2 on machine 2 is 8 + 10 = 18.

Operation 3:
Time transfer the work from machine 2 to machine 1 + Process time of job 2 on machine 1 is 12 + 20 = 32.

Operation 2:
Time transfer the work from machine 1 to machine 3 + Process time of job 1 on machine 3
is 6 + 8 = 14.

Operation 1:
Time transfer the work from machine 3 to machine 1 + Process time of job 1 on machine 1 is 6 + 8 = 14.

Total make span time Ms for Chromosome B is = 12+21+18+32+20+14 = 117.

For Chromosome C: - 4 3 6 2 1 5
Operation 4:
Time transfer the work from L/U to machine 2 + Process time of job 2 on machine 24 + 10 = 14.

Operation 3:
Time transfer the work from machine 2 to machine 1 + Process time of job 2 on machine 1 is 12 + 20 = 32.

Operation 6:
Time transfer the work from machine 1 to machine 2 + Process time of job 3 on machine 2 is 2 + 8 = 10.

Operation 2:
Time transfer the work from machine 2 to machine 3 + Process time of job 1 on machine 3 is 6 + 12 = 18.

Operation 1:
Time transfer the work from machine 3 to machine 1 + Process time of job 1 on machine 1 is 6 + 8 = 14.

Operation 5:
Time transfer the job from machine 1 to machine 3 + Process time of job 3 on machine 3 is 8 + 15 = 23.

Total make span time Ms for Chromosome C is = 14+32+10+18+14+23 = 111

For Chromosome D: - 3 4 2 5 6 1

Operation 3:
Time transfer the work from L/U to machine 1 + Process time of job 2 on machine 12 + 20 = 22.

Operation 4:
Time transfer the job from machine 1 to machine 2 + Process time of job 2 on machine 2 is 2 + 10 = 12.

Operation 2:
Time transfer the work from machine 2 to machine 3 + Process time of job 1 on machine 3 is 6 + 12 = 18.

Operation 5:
Time transfer the job from machine 3 to machine 3 + Process time of job 3 on machine 3 is 0 + 15 = 15.

Operation 6:Time transfer the work from machine 3 to machine 2 + Process time of job 3 on machine 1is 8 + 8 = 16.

Operation 1:
Time transfer the work from machine 2 to machine 1 + Process time of job 1 on machine 1
is 12 + 8 = 20

Total make span time Ms for Chromosome D is = 22+12+18+15+16+20 = 103.

PROGRAMMING INCLUDES

```
#include<iostream.h>
#include<stdio.h>
#include<conio.h>
void main()
{
int lum1=2;
int lum2=4;
int m1m2=2;
int m1m3=8;
int m11m3=6;
int m2m1=12;
int m2m3=6;
int m3m1=6;
int m3m2=8;
```

```
int m3m3=0;
int j1m1=8;
int j1m3=16;
int j11m3=8;
int j11m33=12;
int j2m1=20;
int j2m2=10;
int j3m11=8;
int j3m2=8;
int j3m3=15;
int A,B,C,D,e,f,i,k,m,o,p,q,r,s,t,u,v,w,a,b,c,d,y,z;
int operation , operation1,operation2, operation3;
long int n;
clrscr();
cout<<" Chromosome "<<endl;
cout<<"1 2 3 4 5 6"<<endl;
cout<<"6 5 4 3 2 1"<<endl;
cout<<"4 3 6 2 1 5"<<endl;
cout<<"3 4 2 5 6 1"<<endl;
cout<<"Enter Chormosome for process time"<<endl;
cin >>n;
if (n==123456)
{
A=lum1+j1m1;
B=m1m3+j1m3;
C=m3m1+j2m1;
D=m1m2+j2m2;
e=m2m3+j3m3;
f=m3m2+j3m2;
operation=A+B+C+D+e+f;
cout<<"The total make span time Ms for Chromosome is:"<<operation<<endl;
}
else if(n==654321)
{
i=lum2+j3m2;
k=m2m3+j3m3;
m=m3m2+j2m2;
o=m2m1+j2m1;
p=m11m3+j11m3;
q=m3m1+j1m1;
operation1=i+k+m+o+p+q;
cout<<"The total make span time Ms for Chromosome is:"<<operation1<<endl;
}
else if(n==436215)
{
r=lum2+j2m2;
s=m2m1+j2m1;
t=m1m2+j3m2;
u=m2m3+j11m33;
v=m3m1+j1m1;
w=m1m3+j3m3;
operation2=r+s+t+u+v+w;
cout<<"The total make span time Ms for Chromosome is:"<<operation2<<endl;
}
else if(n==342561)
{
a=lum1+j2m1;
b=m1m2+j2m2;
c=m2m3+j11m33;
d=m3m3+j3m3;
y=m3m2+j3m11;
z=m2m1+j1m1;
operation3=a+b+c+d+y+z;
cout<<"The total make span time Ms for Chromosome is:"<<operation3<<endl;
}getch();}
```

Conclusion

Optimization procedure has been developed in this work is based on genetic algorithm (GA) and is implemented and successfully solved for the scheduling optimization problem of flexible manufacturing system (FMS). Codes are developed and randomized in Ms-Excel. Results are obtained for the 2 problems having 3 machines and 4 machines respectively flexible manufacturing system (FMS). With less calculated effort it's obtained the answer for the massive number of machines and jobs. This work leads to the conclusion that the procedure developed in this work can be suitably modified to any kind of Flexible manufacturing system (FMS) with a large number of machines and components subjected to multi objective functions.

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