



# A Particle Swarm Optimization –Based Heuristic for Scheduling in FMS Review

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**Abstract** – This paper focus on the problem of simultaneous scheduling of machine and automated guided vehicle (AGV) in a flexible manufacturing system (FMS) so as to minimize the makespan The FMS scheduling problem has been tackled by various traditional optimization techniques. While these methods can give an optimal solution to small-scale problems, different scheduling mechanisms are designed to generate optimum scheduling; these include non-traditional approaches such as genetic algorithm (GA), memetic algorithm (MA) and particle swarm algorithm (PSA) by considering multiple objectives, i.e., minimizing the idle time of the machine and minimizing the total penalty cost for not meeting the deadline concurrently. Two optimization algorithms (genetic algorithm and particle swarm algorithm) are compared and conclusions are presented

**Keywords** – Flexible manufacturing system, Genetic algorithm, Particle swarm algorithm, Scheduling Simulated annealing, Memetic Algorithm, Evolutionary algorithms

## I. INTRODUCTION

A FMS is highly sophisticated manufacturing system it meets customers requirement. FMS system has been developed to combine job shop and productive of flow line [1]. In these system consist of three major parts, system including number of CNC machine, automated material- handling system to link with these machine and control system via computer to controlling overall operation of FMS [2].

In FMS scheduling not only includes sequencing of jobs on machine but also required to transfer or routing the jobs on the system. Not only machine or job scheduling consideration takes place but also material handling device AGV and AS/RS must be considering during scheduling during scheduling of FMS.

Scheduling of FMS is different than job- shop scheduling because in FMS each operation of a job may be performed by several machine. an AGV is a material handling equipment that travels on a guided path. The guided path is a segment on which the vehicle is assumed to travel to constant speed.

The goal of schedule is to determine the routing for jobs processing sequence of operation on machine and the starting time for operation in order to balance the work load between machines and maximize the utilization level of machine as well as satisfy the customers demand in time. The measure criterion is minimizing the sum of makes span and average tardiness of scheduling solution.

## II. LITERATURE REVIEW

Oboth C, Batta R, Karwan (1999), presents a heuristic method to solve routing and dispatching problem but not simultaneously scheduling is performed first and sequential path generation heuristic is used to generate conflict free route.

Krishnamurthy et al (1993) they propose an optimization approach. Their objective is to minimize the makespan. They assume that the assignment of tasks of AGV'S is given and they solve the routing problem by column generation

Ayoub Insa Correa et al (2007) developed a hybrid approach for scheduling and routing of automated guided vehicles.

Giffler & Thomson (1960), developed procedure to generate all active scheduling for the general 'n' job 'm' machine problem.

Majid Aboutalebi (2011), distributed flexible manufacturing system (DFMS) scheduling using memetic algorithm, particle swarm optimization & timed petri net.

Reddy and Rao (2006) addressed the simultaneous scheduling problem as a multiobjective problem in scheduling with conflicting objectives. They solved the problem by using a non- dominating sorting evolutionary algorithm.

Abdelmaguid et al (2004) presented a new hybrid genetic algorithm for the simultaneous scheduling problem for the makespan minimization objectives. The hybrid GA is composed of GA and a heuristic.

## III. PROBLEM DESCRIPTION

1. Types and number of machine known.

2. Processing, set-up, loading, unloading time are available.
3. Number of AGV identical and same speed.
4. Flow path layout is given travel time well known.
5. Load/Unload station servers a distribution center.
6. AGV'S carry a single unit load at time.
7. Assignment of operation to machine made machine loading.
8. Ready times of all job are known.

3.1 Assumption

1. Speed AGV= 40 m/min
2. Machine loading
  - Allocation of tools to machine.
  - Assignment of operation to machine are made.
3. Distance between two machines and distance between loading/ unloading are known.

3.2 Objective Function

To minimize the makespan operation

This study is based on single objective function where total operation completion time is the parameters that need to be

Minimized. Total operation completion time,

$$O_{ij} = T_{ij} + P_{ij} \quad (1)$$

Where i= job, j= operation, T<sub>ij</sub>= traveling time, P<sub>ij</sub>= operation processing time.

Job Completion Time (C<sub>i</sub>)=

$$\sum_{i=1}^n O_{ij} \quad (2)$$

Makespan =max (C<sub>1</sub>,C<sub>2</sub>,C<sub>3</sub>-----C<sub>n</sub>)

3.3 Layout of FMS

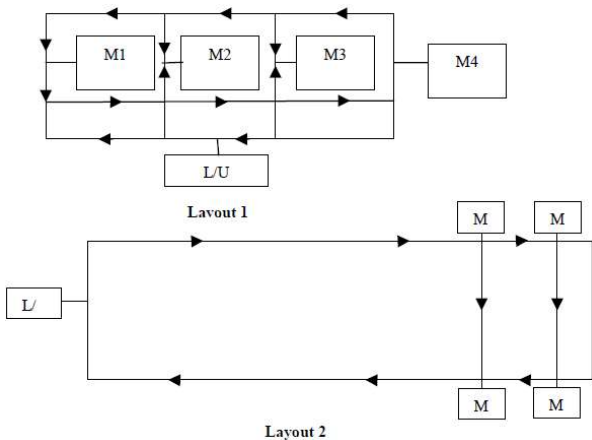


Fig. (A): FMS Structure

IV. GENETIC ALGORITHM

A Genetic Algorithm is an 'intelligent' probabilistic search algorithm that simulates the process of evolution by taking a population of solutions and applying genetic operators in each reproduction. Each solution in the population is evaluated according to some fitness measure. Fitter solutions in the population are used for reproduction. New 'off spring' solutions are generated and unfit solutions in the population are replaced.

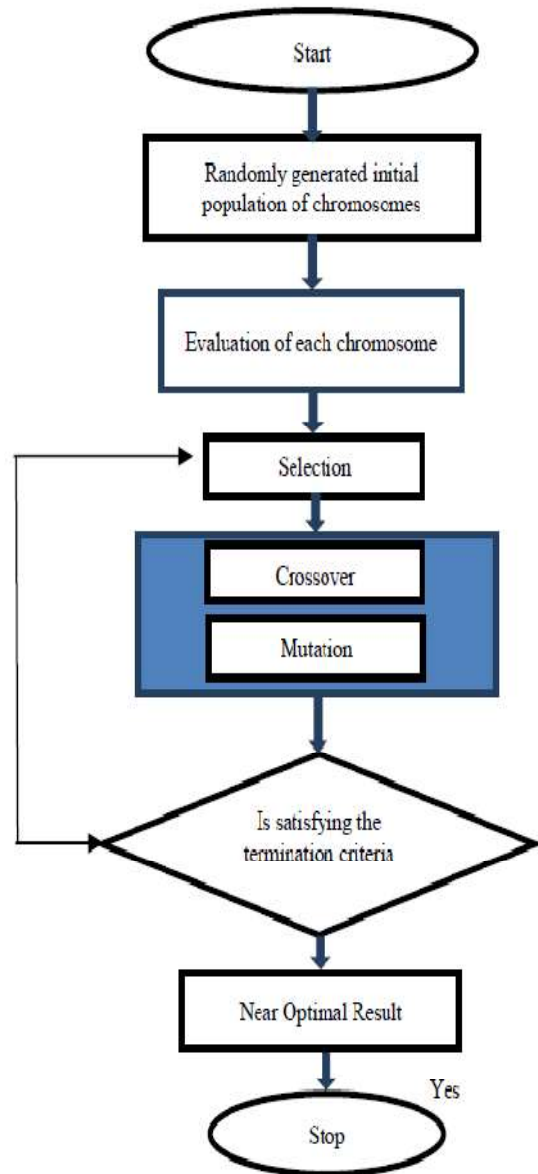


Fig. (B) : Flow chart of Classical Genetic Algorithm.

Step 1. Generate the initial population. Determine the size of the population and the maximum number of the generation.

Step 2. Calculate the fitness value of each member of the initial population.

Step 3. Calculate the selection probability of each member of the initial population using the ratio of fitness value of that

initial population to the summation of the fitness values of the individual solutions.

*Step 4.* Select a pair of members (parents) that can be used for reproduction using selection probability.

*Step 5.* Apply the genetic operators such as crossover, mutation, and inversion to the parents. Replace the parents with the new offspring to form a new population. Check the size of the new population. If it is equal to the initial population size, then go to step 6, otherwise go to step 4.

*Step 6.* If the current generation is equal to the maximum number of the generation then stop, else move to step 2.

#### 4.1 Memetic Algorithm

Memetic algorithms (MAs) is the part of search strategies that use a population based approach in which a set of cooperating and competing agents are engaged in periods of individual improvement to the solution. One of the most well studied problems in this area is single machine scheduling (SMS) the scheduling of  $n$  jobs on a single processor, subject to different constraints and/or cost functions. Many different SMS problems have been solved with Memetic Algorithm. Memetic Algorithms are like Evolutionary algorithms population-based metaheuristics. This means that the algorithm maintain a population of solutions for the problem at hand that a pool comprising several solutions simultaneously.

GA models biological evolution, the memetic algorithm (MA) models cultural evolution, or the evolution of ideas. The main difference between this model and the biological model is that their owner can improve upon the idea. This improvement is obtained by incorporating local search into the GA. The unit of information in the memetic approach is referred to as a meme rather than a gene.

1. Initialise the parameters of the GA.
2. Generate an initial population of solutions for the GA.
3. Use the GA to produce  $n$  'good' solutions.
4. For each of the  $n$  solutions, do the following:
  - Initialise parameters of SA.
  - Improve 'good' solution using SA, and return to GA.
5. Repeat steps 3 and 4 as needed.

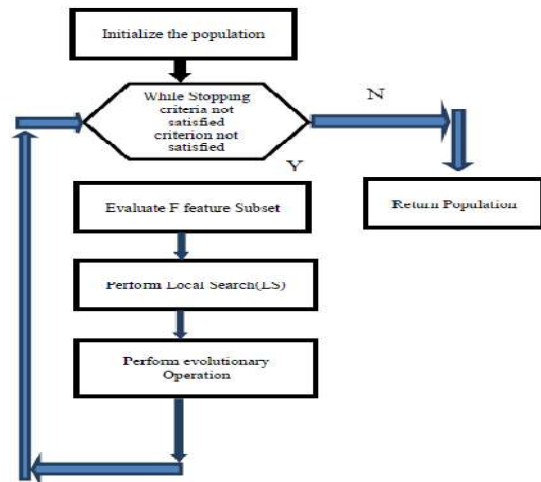


Fig. (C) : Memetic Algorithm Flow chart

#### 4.2 Particle Swarm Optimization Algorithm

Particle swarm optimization (PSO) algorithm is an evolutionary technique developed by Eberhart and Kennedy (1995). Inspired by social behavior of bird flocking or fish schooling and this also been used by many researcher. PSO is similar to genetic algorithm (GA) in that the system is initialized with a population of random solution it is unlike a GA, however, in that each potential solution is also assigned a randomized velocity, and the potential solution, called *particle*, are then "flown" through the problem space. Each particle keep track of its coordinates in the problem space which are associated with the best solution (fitness) it has achieved so far. (the fitness value is also stored) this value is called *pbest*. Another "best" value that is tracked by the *global* version of the particle swarm optimizer is the overall best value, and its location, obtained so far by any particle in the population this location is called *gbest*.

After finding the two best values, the particle updates its velocity and positions with Eqs. 1 and 2 below:

$$V[i] = V[i] + c1 * \text{rand}() * (pbest[i] - present[i]) + c2 * \text{rand}() * (gbest[i] - present[i]) \quad (1)$$

$$Present[i] = present[i] + V[i], \quad (2)$$

Where

$V[i]$  is the particle velocity

$present[i]$  is the current particle (solution).

$pbest[i]$  and  $gbest[i]$  are defined as stated before.  $\text{rand}()$  is a random number between (0,1).  $c1$ ,  $c2$  are learning factors. Usually  $c1 = c2 = 2$ .

##### 4.2.1 Algorithm Steps in PSO

1. Initialize a population of  $n$  particle randomly.
2. Calculate fitness value for each particle. If the fitness value is better than the best fitness value ( $pbest$ ) in history. Set current value as the new  $pbest$

3. Choose particle with the best fitness value of all the particle as the gbest.
4. For each particle, calculate particle velocity according to the equation

$$V[i]=c1*\text{rand}()*(\text{pbest}[i]-\text{present}[i])+c2*\text{rand}()*(\text{gbest}[i]-\text{present}[i])$$

Where  $\text{present}[i]=\text{present}[i]+v[i]$

$V[i]$  is the particle velocity,  $\text{present}[i]$  is the current particle (solution),  $\text{rand}()$  is a random function in the range  $[0, 1]$ .

$C1, C2$  are learning factor=0.5

5. Particle velocity on each dimension are clamped to a maximum velocity  $V_{\max}$ . If the sum of acceleration would cause the velocity on that dimension to exceed max (specified by the user), the velocity on the dimension is limited to  $V_{\max}$ .
6. Terminates if maximum number of iteration is reached. Else, goto step 2.

## V. RESULT

The optimisation procedures developed to perform the task of scheduling on the various non-traditional approaches that have been implemented using C language. Different optimal schedules are obtained for the FMS using the above approaches, The schedule obtain using The PSO the optimum COF values.

## VI. CONCLUSION

The advantages of PSO are that PSO is easy to implement and there are few parameters to adjust. However, PSO does not have genetic operators like crossover and mutation. Particles update themselves with the internal velocity. the information sharing mechanism in PSO is significantly different. In GAs, chromosomes share information with each other. So the whole population moves like a one group towards an optimal area. In PSO, only gBest (or lBest) gives out the information to others. It is a one-way information sharing mechanism. The evolution only looks for the best solution. Particle swarm algorithm is found to be superior and gives the minimum combined objective function.

PSO is suitable tool for this kind of scheduling problems among the non traditional techniques. PSO algorithm is very effective in generating optimal solution for FMS

## VII. REFERENCE

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