ISSN 2616-5775 Vol. 4, Issue 2: 61-65, DOI: 10.25236/AJCIS.2021.040211

MES Scheduling System Based on Mixed Inheritance

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Abstract: *The manufacturing execution system is mainly aimed at the management system of the production workshop and is a bridge between the control layer and the management. It has the function of optimizing and upgrading the production line. In this paper, we will briefly introduce the current situation of production scheduling, the function, execution principle and function of manufacturing execution system, and then introduce the hybrid genetic algorithm as the core scheduling algorithm of manufacturing execution system, the combination of simulated annealing algorithm and genetic algorithm, and their execution process, and evaluate the actual results. The system will use genetic algorithm and simulated annealing algorithm to select the optimal scheme in the randomly generated scheduling scheme, and select the optimal progeny individuals through continuous genetic iteration and annealing screening. The time complexity is reduced and the production efficiency of the production line is improved.*

Keywords: *MES, manufacturing execution system, scheduling, simulated annealing algorithm, genetic algorithm, hybrid genetic algorithm*

1. Introduction

At present, the utilization rate of manufacturing execution system is very high in the management and scheduling of factory production, which is greatly advantageous because of its digital analog factory production information, and has been favored by its excellent management ability and adjustment level. However, the production capacity of manufacturing execution system is not limited, many of which can be greatly improved. Simulated annealing algorithm plays an important role in many optimal problems [1] Here our pipeline scheduling algorithm based on simulated annealing algorithm and genetic algorithm is a local improvement for fast scheduling and optimal production scheme.

Manufacturing execution system has a long research history. Based on the earliest production execution manufacturing system is based on the earliest classical simulated annealing algorithm proposed by American scientists in the last century. Knopp et al. [2] proposed a method based on hybrid simulated annealing algorithm and local search algorithm. It reduces the working time and has high efficiency in solving the multi-objective workshop scheduling problem. After discussion, we find that genetic algorithm can further improve the production scheduling ability of its assembly line, so there is a hybrid genetic algorithm MES manufacturing execution system which realizes multiple scheduling macro selection by genetic algorithm and local optimal solution checking by simulated annealing algorithm.

2. System description and module design

2.1 System description

The system is composed of planning scheduling management, production scheduling management, inventory management, procurement management, cost management project Kanban management, production process control and other modules. When using this system, we need to register the newly added devices, employees and other information in the registration module. At the same time, in the process of transaction, the system will automatically store the transaction information such as amount change, inventory change, purchase and sale information, so as to facilitate the administrator to find the transaction record information. The composition of the system is shown in figure 1 below:

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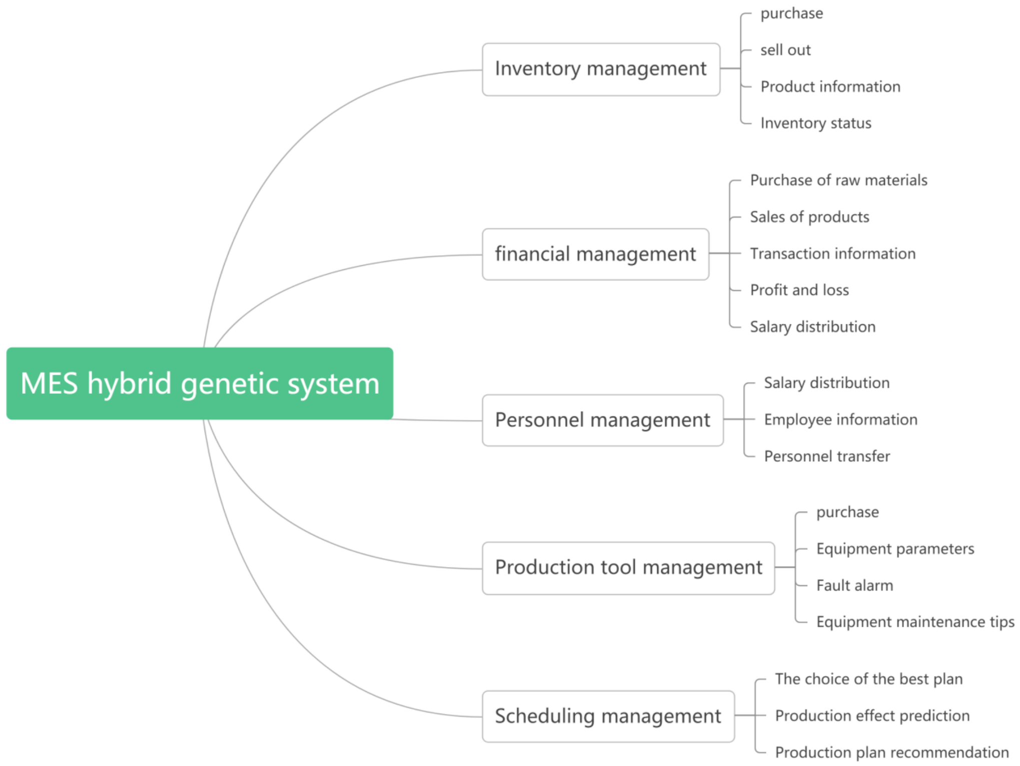

Figure 1: Composition diagram MES hybrid genetic algorithm

After starting the program, the administrator user logs in or registers to enter the system. If there is no data in the system at this time, the administrator can add / modify / delete the data, or register new employees, new devices, etc. After the data is entered, the administrator can start the scheduling page. The system implementation flow chart is shown in figure 2 below:

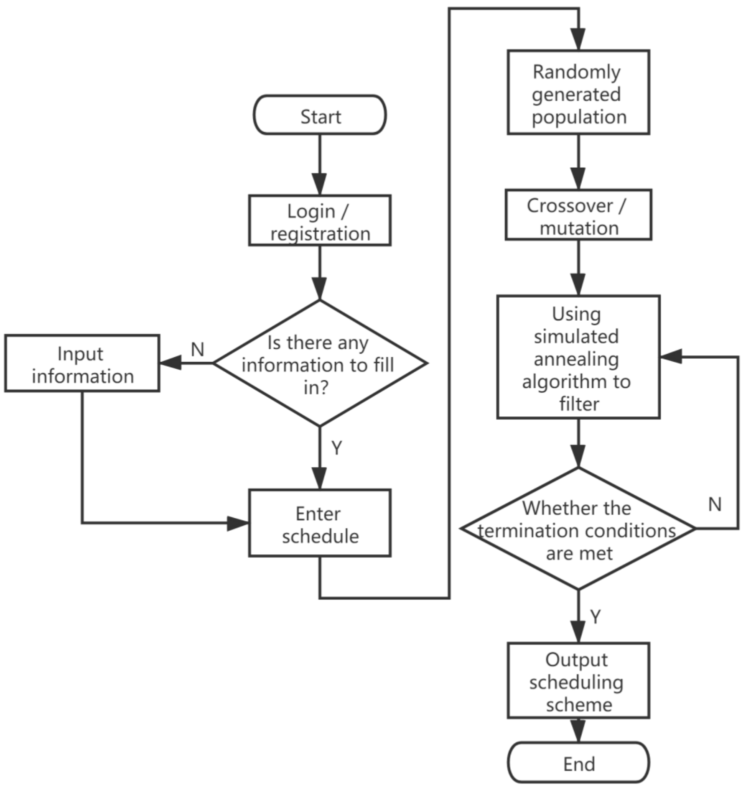

Figure 2: Flowchart of MES System of Hybrid Genetic Algorithm

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2.2 Module design

2.2.1 Genetic selection module

Genetic algorithm [4] (genetic algorithm, GA) is an algorithm based on the principle of gene genetics and natural selection in biology to find the optimal solution. It is suitable for processing production scheduling problems and can provide robustness for scheduling solutions.

It uses population search to evolve to a state that contains or approaches the optimal solution by genetic manipulation of current population selection, crossover, variation, etc. Compared with other algorithms, the coding technology and genetic operation of genetic algorithm are relatively simple, which can improve efficiency and can not easily fall into the [5] of local minima.

The MES system based on mixed heredity has special combination characteristics and process constraints. We use the following coding method: a chromosome represents a scheduling mode. Each gene on each chromosome represents a production step of a production product, in which i represents the product type, j represents the production link, for example:$G_{1,2,3,4......}$, $O_{11,12,13,......ij}$

$\boldsymbol{G_1}$={$\boldsymbol{O_{11}O_{21}, O_{12}, O_{22}}$}

Since the product can only be produced in order, the above formula can be abbreviated as

$\boldsymbol{G_1}$=*{1,2,1,2}*

$B_{1,2,3,4.........}$The chromosome is accompanied by another one-to-one chromosome, and each gene of the accompanying chromosome represents the production facility code corresponding to a production product.$F_{1,2,3.4.........}$$\boldsymbol{R_1}$A complete chromosome can be represented as follows:

$\boldsymbol{G_1}$=*{1,2,2,3,1,3,2,1}*

$\boldsymbol{B_1}$=*{1,1,2,4,2,3,1,2}*

In this program, there are 3 kinds of products, 3 steps of 1,3 steps of 2,2 steps of 3,1 of 1 on machine 1, and so on.

2.2.2 Simulated Annealing Selection Module

After genetic crossover and mutation in the population, the offspring produced by roulette selection are proportional to the fitness, and a better selection effect can be obtained. However, in the later stage of the algorithm, the fitness tends to be consistent and the advantages of excellent individuals are insufficient. We use simulated annealing algorithm to screen the population, which ensures that the chromosome population will not be precocious and that the excellent genes of the inferior population will be inherited. Get the best solution that meets its requirements. When we obtain the population after genetic algorithm, we start to calculate. According to the Metropolis criterion, when the system temperature is T, the cooling probability of dE energy difference is:$R_{1,2,3,4.....}$$R_1$

$$p(dE) = e^{dE/kT}$$

∈ The energy difference is dE the difference between the old and the new fitness, that is, when the fitness increases, the p>1 indicates that the system will choose the R as the new optimal solution. If the fitness decreases, the dEdE=f'-f, 0, the smaller the p, the lower the selection probability.

At the same time, the difference between the new fitness after variation and the fitness before variation is calculated. If the fitness after variation is larger, the variation is accepted, and if the fitness after variation becomes smaller, a certain annealing probability exp (de/T) is used to determine whether the variation occurs. This operation improves the efficiency of genetic algorithm, but also avoids precocious appearance to some extent.

2.2.3 Implementation steps

The implementation steps of hybrid genetic algorithm for cross iteration are as follows:

(1) Through the client input indicators, according to the relevant process to make initialization model.

(2) The population is initialized, the indexes entered in step 1 are reconstructed, and the genes are generated by random function to generate 100 population numbers, and the fitness is calculated to select the relatively optimal 50 populations.

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(3) $T_{di}T_iQ_i$The output value of each product according to the bound standard of product value according to the final product deadline completion time and product completion time

$$\boldsymbol{W_i} = \begin{cases} \boldsymbol{Q_i} & \boldsymbol{T_i \le T_{di}} \\ \boldsymbol{0} & \boldsymbol{T_i > T_{di}} \end{cases}$$

Then the fitness function can be written:

$$\boldsymbol{f_i} = \sum_{\boldsymbol{i=0}}^{\boldsymbol{j}} \boldsymbol{W_i}$$

(4) Under the principle of chromosome crossover, when two chromosomes cross R1, R2, only the corresponding chromosomes (G pairs of G,R pairs of R) cross according to a certain probability. Other digits also need to change as required to prevent errors.

(5) The probability of crossover and mutation will be given by the following formula:

$$\boldsymbol{P_C} = \begin{cases} \boldsymbol{P} \times \dfrac{\boldsymbol{f_{max} - f'}}{\boldsymbol{f_{max} - \overline{f}}} & \boldsymbol{f' \ge \overline{f}} \\ \boldsymbol{P} & \boldsymbol{f' < \overline{f}} \end{cases}$$

$P_C f_{max} f' \bar{f}$Among them, it is the probability of crossover and mutation, the maximum adaptive function value, the larger adaptive value of the two individuals involved in the crossover operation, the average adaptive value of the evolutionary population, P the set crossover / variation value. This way can avoid the destruction of the dominant population, and enable other populations to find the dominant population faster.

$R_{1,2,3,4.....}R_1$(6) We have calculated from the beginning in the population after obtaining genetic algorithm. According to the Metropolis criterion, when the system temperature is T, the cooling probability of dE energy difference is:

$$p(dE) = e^{dE/kT}$$

The energy difference is dE the difference between the new and the old fitness, that is, when the fitness increases, the p>1 indicates that the system will definitely choose the R as the new optimal solution. If the fitness decreases, the dEdE=f'-f ,0, the greater the p [0,1], and decrease, the smaller the p, the lower the selection probability, the smaller the selection probability∈

(6) Set the cooling coefficient n, temperature after heating T, the lowest temperature, the current temperature t gradually cooling according to the following equation: T_{min}

$$\boldsymbol{t = n \times T}$$

T_{min} when t<, the cycle terminates and the system selects the maximum value as the optimal solution output.

3. Conclusion

A mathematical model based on annealing principle and genetic principle is established to optimize the efficiency of plant assembly line. A MES-oriented genetic simulated annealing algorithm is proposed. The following results are obtained through experimental calculation:

(1) Has realized the basic factory MES management, can handle the personnel movement, the capital inflow expense, the product sale, the raw material purchase and so on basic management task, and can view the factory equipment management transportation situation in real time.

(2) A MES - oriented simulated annealing algorithm and a genetic algorithm are proposed and applied to pipeline production to reduce time complexity and improve production efficiency.

(3) The algorithm adopts a variety of constraints to ensure that there will be no wrong extreme phenomenon in the process of scheduling, make scheduling more humanized, more in line with people's cognition, ensure its authenticity, and have practical significance.

(4) The hybrid genetic algorithm can quickly obtain the macro processing level by using the genetic algorithm, but there is still a lack of local processing, and the simulated genetic algorithm solves this

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problem properly, and the use of the hybrid genetic algorithm is innovative.

This paper puts forward the idea of hybrid genetic algorithm in terms of production line level, which can be used to improve its production level. The next step of analog genetic algorithm can be applied to more abstract areas such as capital purchase, warehouse management, personnel transfer and so on, so that MES can be more intelligent and further improve the actual production capacity of MES.

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