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## Study on Optimal Scheduling of RGV in Industrial Production

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# Study on Optimal Scheduling of RGV in Industrial Production

Penghui Yin \*

School of North China Electric Power University (Baoding), Baoding, China

\* Corresponding author e-mail: 13931784065@163.com

**Abstract.** In modern industrial production, a large number of production scheduling problems exist. We set up the actual integrated scheduling model of production workshop to analyze the actual scheduling problem of the factory. The optimal scheduling situation is obtained through the establishment of the "minimum time cost model" simulation, and the optimal scheduling is solved through the modification of the chaotic genetic algorithm to maximize the efficiency and benefit of production. In addition, the time required to complete the one-cycle process of RGV is solved by simulation and the time points of each step are listed. Finally, the optimal production scheduling scheme is given.

**Keywords:** Dynamic scheduling, Simulation model, Chaos genetic.

## 1. Introduction

With the rapid development of intelligent processing system, the Rail Guide Vehicle (RGV) has become the mainstream of modern industrial production development. RGV is a fixed track intelligent vehicle which can automatically control the direction and distance of movement according to the instructions given by Computer Number Controller (CNC). It has two mechanical arms and material cleaning trough, and can complete the tasks of loading and unloading and material cleaning. In the working process of RGV, when the material of a process is processed, each CNC machine is installed with the same cutter, and the material is arbitrarily selected by CNC. We simulated the actual production process of the factory. A schematic diagram of an intelligent processing system, consisting of 8 CNC machines, 1 track-type automatic guidance vehicle (RGV), 1 straight RGV track, 1 feeding conveyor belt, 1 feeding conveyor belt and other ancillary equipment.

In this paper, we simulated the production process of the production workshop and established a comprehensive scheduling model to solve the problem of production scheduling optimization. The optimal scheduling and the time needed to complete a cycle are obtained by simulation method, and the starting and ending time of each step is obtained by genetic algorithm to better analyze the production process.



## 2. Models and Algorithms

### 2.1. Minimum time cost simulation model

According to the processing of materials in one process, each CNC machine has a certain processing time, and CNC has different time to issue the upper and lower material number. Therefore, in order to make the system process more materials within 8 hours per shift, the specific scheduling process of RGV should follow the principle of minimum time. The time  $t_i$  required to complete the  $i$ th job includes: the time  $t_{mi}$  required to perform RGV movement of the  $i$ th job, the time  $t_{ri}$  needed to complete the first feeding and feeding of CNC, the time  $t_{oi}$  needed to complete the cleaning of a material by the  $i$ th job RGV, and the time  $t_{wi}$  needed for CNC to wait for the  $i$ th job.

$$t = t_{ri} + t_{mi} + t_{oi} + t_{wi} \quad (1)$$

Among them, the waiting time for the  $i$ th operation of CNC includes the time required for CNC machining and the time waiting for RGV to arrive after finishing machining; The waiting time  $t_{wi}$  in twister is generated by computer simulation iteration after finishing processing and waiting for RGV to arrive; Since RGV has different feeding time for CNC with even number and odd number,  $t_{ri}$  is determined by the odd and even number of CNC.

According to the assumption, the RGV intelligent vehicle starts from static to uniform acceleration,  $t$  is the uniform motion time of each RGV, Let the distance that RGV needs to move in job  $i$  is  $x_i$ . If  $x_i \geq 0$ , then

$$t_{mi} = \frac{x_i - x}{v} + t \quad (2)$$

When the distance of RGV movement required for the  $i$ th job is 0, it means that RGV does not need to complete the movement, and the required operation can be completed in situ. At this point,  $t_{mi} = 0$ .

For the system to work 8 hours, Only when  $\min \sum_{i=1}^N t_i$  is obtained can more materials be processed.

In the process of obtaining  $\min \sum_{i=1}^N t_i$ , it is necessary to consider which CNC shall be used by RGV when receiving different CNC signals.

Finally, the above minimum time cost model is implemented through Matlab program simulation. The strategy verification was carried out through simulation, so as to solve the problem that the dynamic scheduling mathematical model of RGV is difficult to directly express.

### 2.2. Improved chaos genetic algorithm

The strategy verification is carried out through simulation, and only the existing enumerated policies can be screened. [1] Therefore, in order to better screen out the sequences of simulation input, the simulation is embedded into the genetic algorithm. Genetic Algorithm (GA) has potential parallel characteristics, faster searching ability and better global optimization. [2] To solve RGV dynamic scheduling problem, we use the improved chaotic genetic algorithm, which can better represent the internal randomness of the system and improve the precocious problem of genetic algorithm. At the same time, the coding method based on CNC number and the method of adding new individuals in the

case of cross variation can be adopted to enable RGV to find the line mode that makes the system run most efficiently.

(1) Initial solution

Since the genetic algorithm converges in parallel, we obtain the initial solution through stochastic optimization to ensure the uncertainty of the initial solution, and the obtained initial solution starts iteration as the initial point.

(2) Encoding and decoding

As the material process can be processed by different CNC machine tools (CNC), CNC coding and different processes need to be considered when considering the coding method. Therefore, based on the given CNC number 1, 2, 3, 4, 5, 6, 7 and 8, the actual number of CNC is selected as the encoding method of CNC. The number of CNC is the length of the gene string in the coding.

(3) Mutation

The aim of mutation operation is to accelerate the convergence speed and avoid the problem falling into local optimum, and at the same time to realize the diversity of population and guarantee the global optimum. [3] First, the appropriate mutation rate is selected and the corresponding gene mutation is randomly selected. Then, the original gene value is taken as the initial value and the chaos sequence is used for appropriate number of iterations. The specific sequence is

$$x(n+1) = 4x(n)(1-x(n)) \quad (3)$$

Thus, the disturbance to the “original chromosome” is increased to obtain the new chromosome.

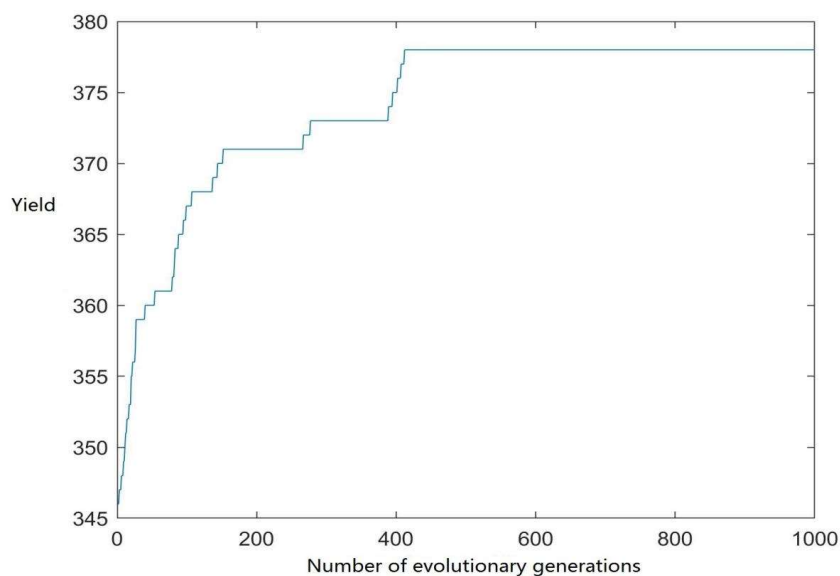
(4) Cross

By taking the random initial value within the interval (0,1), Logistic chaos sequence  $x(n+1) = 4x(n)(1-x(n))$  is applied to generate a chaotic value, which is on the interval (0,1) and the initial value of the next generation cross term. By cross - crossing, the individual with higher fitness value is produced.

(5) New individuals added

(6) Eliminate

Select the first 50 individuals to be selected by sorting the fitness from high to low, and eliminate the others, and keep the total number of individuals to be 50.



**Figure 1.** Genetic generation number and yield

### 3. Optimal Production Scheduling

We use the above improved chaotic genetic algorithm based on the minimum time cost model to simulate true. By simulating a fixed system and feeding back to the improved chaotic genetic algorithm, the adaptive degree is calculated; [4] Then, the value is randomly selected in the interval (0,1), which is relatively thick [4] and can traverse all points in the interval to obtain the global optimal solution. Secondly, chaotic sequences are used to iteratively produce progeny sequences, and the solutions are obtained through mutation and crossover before simulation. The optimal model of the final RGV dynamic scheduling is obtained by looping this process for 1500 times through the program

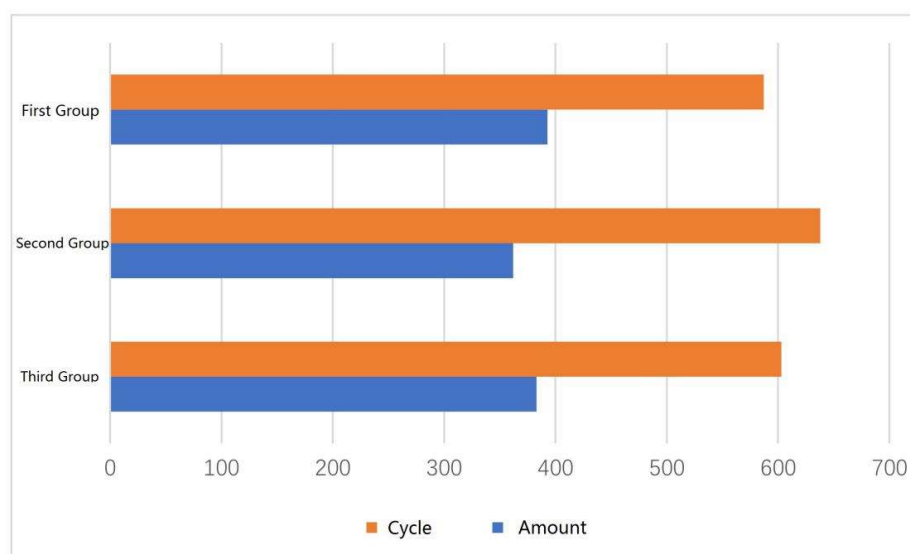
### 4. Solution Results and Analysis

The three groups of system data were simulated and solved, and it was found that the optimal scheduling of the three groups of system data was in cyclic state, taking 8 groups as a cycle. The 8 CNCs through the cycle cycle are just the number of all CNC, so 8 CNCs will finish the processing of materials within each cycle. We analyze this result. For a fixed specific system, its system operating parameters will not change due to external disturbance. At this time, the optimal scheduling strategy of RGV seeking is in accordance with a fixed sequence cycle. Fixed sequence selection is based on the principle of minimum time cost and minimum distance.

Work efficiency is defined as the number of materials produced per hour. Thus, the productivity of data 1 was 47.875 / h, that of data 2 was 42.25 / h and that of data 3 was 49.125 / h.

**Table 1.** Solution results for three groups of data

Groups	The loop sequence	Total amount	Period(s)
1	8, 7, 5, 3, 2, 1, 4, 6	383	603
2	3, 1, 2, 4, 5, 8, 7, 6	362	638
3	8, 7, 6, 3, 1, 2, 4, 5	393	587



**Figure 2.** Cycle time and total number of three sets of data

We sorted three sets of data according to the time of system operation parameters and found that they were arranged in descending order according to the second group, the first group and the third group. By analyzing the simulation results, we found that the amount of materials completed in 8 hours is arranged in ascending order according to group 2, group 3 and group 1, and the time of each material cycle is arranged in descending order according to group 2, group 1 and group 3. Based on the principle that the longer each material takes, the lower the number of materials completed within 8 hours, the simulation results can well meet this principle and have certain practical operation significance.

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