Research on Intelligent RGV Scheduling Strategy

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Abstract: With the continuous development of intelligent processing systems, how to maximize the efficiency of intelligent machines has become an important issue to be studied. According to the working conditions of RGV, the corresponding model is established and the specific data is analyzed and calculated. Through the analysis of the RGV workflow, the factors affecting the processing system are mainly the distance between the RGV and the CNC, the initial discharge sequence and the loading and unloading time of different sides.

Task 1: Establish a model. The priority P1=Si+T is defined, and the service order of the RGV is determined by the size of P1. Taking time as the standard, the priority Si of different distances and the priority T of the two sides of the loading and unloading time are obtained, and then the value of P1 is judged every time the RGV moves by one unit, and the optimal value service order can be continuously determined during the RGV movement process. Through the violent search, the optimal initial discharge sequence is obtained, and the most efficient dynamic scheduling is formed.

Task 2: Test the model. Bring three sets of data into the model. To verify the validity of the model's practicality, a scheduling scheme with reference standards needs to be developed. If the number of processed materials calculated by RGV under the defined dynamic scheduling is greater than the number of materials obtained under the original scheduling scheme, it can be verified that the model is practical and effective.

The definition model considers the distance between the RGV and the CNC which is sending signal, the time of different processes, etc. The setting of the priority rule greatly increases the processing efficiency of the system, and the violent search improves the optimality of the dynamic scheduling scheme.

1. The composition of the intelligent processing system

1.1 System Scene Description

In Figure 1, the intermediate device is a rail-type automatic guided vehicle RGV with a cleaning tank and a robot. The cleaning tank can only clean one material at a time, and the front end of the robot arm has two claws, which can grab a material by rotation. The materials are completed at the same time. The CNC is arranged on both sides, and a material conveyor belt is installed in front of each CNC. On the right is the loading conveyor, which is responsible for conveying the raw material (unprocessed material) for the CNC; the left is the unloading conveyor, which is

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responsible for sending the finished material (processed and cleaned material) out of the system. Other auxiliary equipment to ensure the normal operation of the system. It works 8 hours per shift.

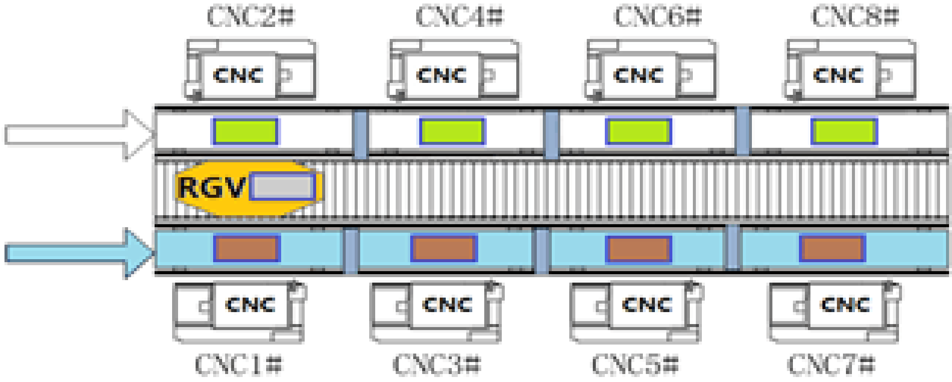

Figure 1

1.2 System composition and description

The intelligent processing system consists of 8 CNCs, 1 RGV with robot and cleaning tank, 1 RGV linear track, 1 Loading conveyor belt and 1 Cutting conveyor belt and other ancillary equipment constitute.

(1) CNC: Install 4 CNCs on both sides of the loading conveyor and the unloading conveyor, equidistantly arranged.

(2) RGV: RGV has an intelligent control function that can receive and send command signals. According to the command, it can move on the linear track and stop waiting. RGV can only perform one of moving, stopping waiting, loading and unloading, and cleaning at the same time.

(3) After the intelligent processing system is powered on, the RGV is in the initial position between the CNC1# and CNC2#, and all the CNCs are in the idle state.

2. Task analysis

2.1 Task one

During the RGV movement, demand signals from different CNCs are received. The purpose is to sort the demand signals so that the system can process the most materials in a certain period of time. First analyze all the factors that will affect the efficiency of RGV, then give priority to these factors according to the degree of impact, and then decide which location RGV to work according to the priority.

2.2 Task two

Three sets of data from the table need to be brought into the model. To verify the effectiveness of the algorithm, it is necessary to set a scheduling scheme with low efficiency in general as a reference standard. By comparing the total number of materials processed by the two scheduling schemes, if the number of objects processed by the designed scheduling model is higher, We can prove that the algorithm is very effective. For the RGV scheduling strategy, variables can be set in the algorithm of the model to record the scheduling changes of the RGV when the RGV is working. For work efficiency, it is necessary to analyze the relevant formula and perform calculations.

3. Symbol Description

Table 1

Symbol	Explanation
P1	Priority
S	The distance priority of the CNC that sends the demand signal to the RGV
T	Priority of loading and unloading time
ta	Total time of RGV work
to	CNC completes the working time of the material
tc	RGV standby time and moving time sum
t1 t2 t3	Move one, two, three units of time
td	Loading and unloading time of the lower CNC
tu	Upper and lower CNC loading and unloading time
η	Work efficiency

4. Model establishment

4.1 Analysis of influencing factors

Through analysis, it is found that during the working process of the system, the distance between the RGV and the CNC that sends the demand signal, as well as the difference between the loading and unloading time, and the initial discharge sequence are three important factors that affect the efficiency of the system. It is necessary to get optimally order of each CNC that sends out signals to process as much material as possible within a fixed time. According to the principle of the shortest consumption time, the time of the data table is calculated. The closer the CNC priority is to the RGV, the higher the priority of the CNC with less loading and unloading time. Therefore, in the case which the number of units of the RGV is the same, the CNC of the lower side should be preferentially served; when the demand signal is sent on the same side, the CNC with a short service distance is preferred; when the number of units of the RGV is the same and both are on the same side, the priority service The side with a large number of CNCs. When the two factors are different, consider the following:

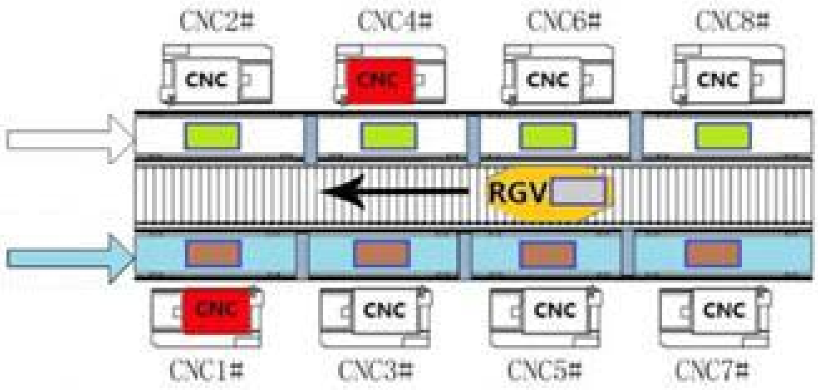

Figure 2

When RGV moves to the position of CNC5#, CNC4# and CNC1# simultaneously send out the demand signal. At this time, it is calculated that the priority service CNC4# can use less time, so it is concluded that the distance and the loading and unloading time are When comparing, the distance factor should be given priority.

4.2 Model establishment

The priority P1 is determined by the following formula:

$$P1 = Si + T (i = 1, 2, 3)$$

Where Si represents the priority when the distance is i units, and T represents the priority of the loading and unloading time. The unit number S specifying the distance between the RGV and the CNC can only be 0, 1, 2, 3. On this basis, it is assumed that the time for moving one unit is t1, the time for two units is t2, and the time for three units is t3. Assume that the priority when not moving is 0. The smaller the size of the number, the higher the priority, you can get:

$$Si = \frac{ti}{t1} (i = 1, 2, 3)$$

It is also assumed that the loading and unloading time of the lower CNC is td, and the loading and unloading time of the upper CNC is tu:

$$T = \frac{td - tu}{t1}$$

According to this, a series of matrices about P can be obtained. For example, when the RGV is at the position of CNC8#, the matrix is:

$$\begin{bmatrix} S3 + T & S2 + T & S1 + T & T \\ S3 & S2 & S1 & 0 \end{bmatrix}$$

So the formula that gives the priority P1 is:

$$P1 = \frac{ti}{t1} + \frac{td - tu}{t1} (i = 1, 2, 3)$$

After the priority formula is determined, an optimal initial discharge sequence can be obtained by performing a violent search on the initial discharge sequence. At this time, an optimal scheduling scheme can be obtained.

Two states are set for each CNC. One is to issue the demand state, and the other is the working state. When the CNC becomes the working state, the variable is set to record the working time of the table CNC. When the work is completed, the state changes. A demand signal is sent and the working time is cleared to prepare for recounting. After the RGV receives the demand signals from different CNCs, it first sorts their priorities to determine which CNC to service. Because of the contingency of the demand signal, the RGV is set to determine the priority ranking every time one unit is moved. In this way, when the demand signal changes, the optimal decision can be made in the shortest time.

5. Model inspection

5.1 Analysis

The original scheduling scheme is defined as follows: When the RGV does not have any scheduling policy, the order in which the CNC signals is the order of the initial feeding of the RGV, and the RGV serves the CNC only in the order of the initial feeding in the service process. If the number of processed materials calculated by RGV under dynamic scheduling is greater than the number of materials obtained under the original scheduling scheme, it can be verified that the algorithm is valid.

For the scheduling strategy, a variable is defined in the algorithm to record the number of the CNC of the service during the RGV movement, and a series of changes of the variable can be read to obtain the dynamic scheduling of the RGV.

The calculation formula for the operation efficiency is:

$$\eta = \frac{ta - tc}{ta} \times 100\%$$

Where ta represents the total working time of RGV, tc represents the time of RGV standby and the time of displacement during operation. In the model, the values of ta and tc are recorded by variables, and the working efficiency of the system work can be obtained.

5.2 Substituting data

In order to test the practicability and effectiveness of the model, three sets of system operating parameters were given, as shown in the following Table 2.

Table 2

System operation parameters	Group 1	Group 2	Group 2
Time that the RGV move 1 unit taking	20	23	18
Time that the RGV move 2unit taking	33	41	32
Time that the RGV move 3 unit taking	46	59	46
Time that the CNC deals a material for one process taking	560	580	545
Time that RGV load and unload a material for CNC1#, 3#, 5#, 7# at one time taking	28	30	27
Time that RGV load and unload a material for CNC2#, 4#, 6#,8# at one time taking	31	35	32
Time that RGV completes a cleaning operation of a material taking	25	30	25

The table in which the first group of data in the data table is substituted into the priority calculation formula to obtain the priority P1 is shown in Table 3.

Table 3

	0 units	1 units	2 units	3 units
CNC on the upper side	0.15	1. 15	1.8	2.45
CNC on the underside	0	1	1.65	2.3

The second set of data in the data table is substituted into the case-first calculation formula, and the table of priority P1 can be obtained as shown in Table 4.

Table 4

	0 units	1 units	2 units	3 units
CNC on the upper side	0.22	1. 22	2.00	3.79
CNC on the underside	0	1	1.78	2.57

The table in which the third group of data in the data table is substituted into the case-priority calculation formula, and the priority P1 can be obtained is shown in Table 5.

Table 5

	0 units	1 units	2 units	3 units
CNC on the upper side	0.28	1. 28	2.06	2.84
CNC on the underside	0	1	1.78	2.56

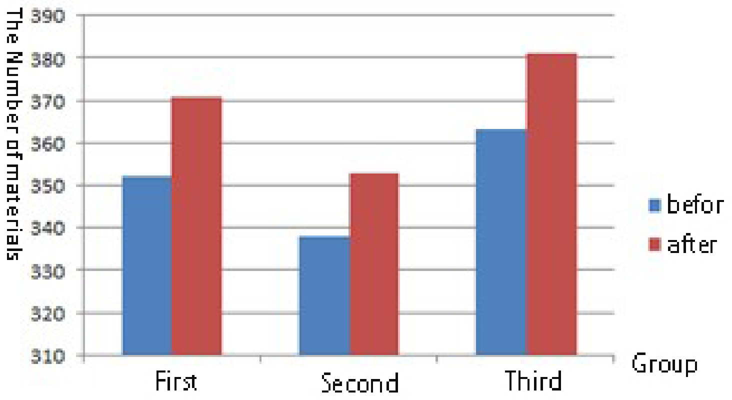

Figure 3

The number of materials processed by the three sets of data of the two scheduling schemes is counted, and Figure 3 is obtained.

It can be seen from the figure that under the dynamic scheduling of the design considering the priority, the number of processed materials in the same time is obviously increased, which can prove the practicality and effectiveness of the model.

Through calculation, we can get the working efficiency of model one in three sets of data as shown in Table 6.

Table 6

Situation one	effectiveness
First set of data	68.39%
Second set of data	75.11%
Third set of data	70.27%

6. Conclusion

The influence of the distance between the RGV and the CNC that issued the corresponding request and the difference of the loading and unloading time on the efficiency of the system work is analyzed. The value of the priority is given by the specific calculation of the algorithm, and the model is established. According to the constant changes of the influencing factors, the model is optimized to adapt the model to more complex actual situations and the application is strong. There will be unanalyzed factors in the actual movement of RGV, so the model may have certain limitations. Due to the limited test data, this model may not be applicable to certain data.

References

[1] Information on: http://www.mcm.edu.cn/html_cn/node/7cec7725b9a0ea07b4dfd175e8042c33.html