Dynamic scheduling of workshop RGV

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Abstract

This paper studies the dynamic scheduling of RGV in the working state of intelligent processing systems. In the research process, the scheduling efficiency is the main goal, and it is transformed into the shortest task time in the specific analysis process, and then the path selection optimization is considered. Taking into account the dynamic multi-objective characteristics of RGV, Dynamic Programming [1] is used to segment the motion of RGV. The goal with the shortest total time to complete the mission of RGV is to associate the Dijkstra algorithm [2] with the optimal path and improve it to achieve the goal of dynamic scheduling.

Keywords

RGV; shortest task time ; Dynamic Programming ; Dijkstra algorithm; optimal path.

1. Introduction

With the development of the economy, dynamic scheduling of industrial workshops is becoming more and more important, and intelligent scheduling can reduce manpower and material resources. An intelligent machining system consists of 8 Computer Numerical Controllers (CNC), 1 Rail Guide Vehicle (RGV), 1 RGV linear track, 1 loading conveyor, 1 unloading conveyor And other auxiliary equipment. RGV can automatically control the moving direction and distance according to the instructions, and comes with a robot arm, two mechanical grippers and material cleaning tanks, which can complete the tasks of loading and unloading and cleaning materials.This paper mainly introduces how to perform scientific scheduling .

2. Trouble-free single operation scheduling method

It is considered that each task of the RGV processing does not affect each other independently, and is not interfered by the remaining signals during the processing of a certain task. Try to introduce the DP algorithm in the dynamic programming design, and further decompose the RGV motion process. Each task is regarded as a stage, and each stage makes a decision. The decision situation of one shift can constitute a decision sequence.

The whole is regarded as a multi-stage dynamic scheduling model, which achieves global strategy optimization by seeking local optimality. When making specific decisions, you need to choose a reasonable path optimization algorithm. The Dijkstra algorithm is designed to calculate the shortest path from one vertex to the rest of the vertices. The path in the directed graph is compared with the time in this problem, and the applicability of the algorithm can be found.

When the system performs a process operation, the RGV motion flow chart is shown in Figure 1:

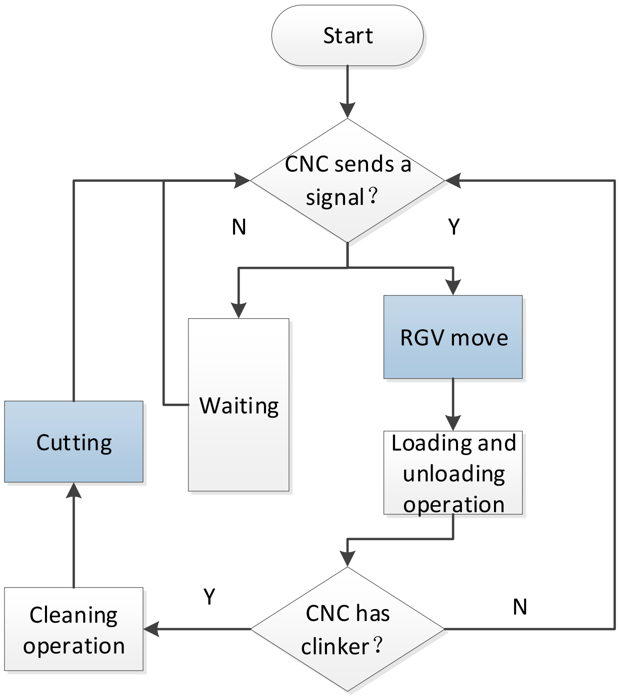

Figure 1. RGV scheduling flowchart

The specific process is as follows:

1) Take the RGV position per second as the origin;

2) Set eight machines to eight vertices;

3) Remember that RGV can reach the set of vertices as P. For each CNC, if it is in the state of signal sending, it will be added to the set P, and each station will be analyzed to obtain the specific time RGV can reach the vertex set P;

4) Calculate the shortest path from the origin to each point in the set P, and get the shortest distance from RGV to P at this moment;

5) Take the shortest path as the RGV target position.

In the calculation process, we found that when two CNCs equidistant from the RGV signal, the RGV will not be able to determine the minimum path. From the simplicity of programming and execution, we set the left if the RGV receives the signal. The side area will move to the left side preferentially; if the RGV is in the right area when it receives the signal, it will move to the right side preferentially, so that the priority of the RGV movement can be completed.

The above process is performed in Java, and the specific scheme when the RGV collects signals at different locations can be obtained.

The following shows the execution characteristics of the algorithm in two typical states of RGV:

The entire intelligent machining system is divided into four areas. When starting work, there are four possibilities for the location of the RGV:

Located between CNC1# and CNC2# (Zone 1); between CNC3# and CNC4# (Zone 2);

Located between CNC5# and CNC6# (Zone 3); between CNC7# and CNC8# (Zone 4).

（1）When RGV is located in area 1, it is obvious that its direction of motion should default from left to right as Figure 2:

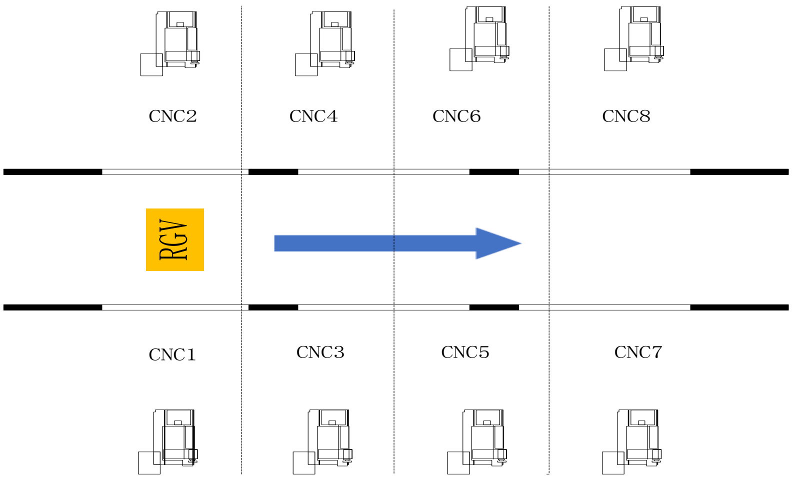

Figure 2. RGV is located in zone 1

(2) When RGV is located in area 2, if there is a signal around RGV, RGV will always prioritize the left task; if the symmetric CNC on both sides of the track signals, the odd-numbered CNC will be processed first.

The visual representation is as Figure 3. In the figure below, CNC1 on the left side of RGV signals, and CNC5 and CNC6 on the right side send signals (CNC5 and 6 are symmetrically distributed on both sides of the track), then RGV will process the task of CNC1 first, then the right side. The task of CNC5, and finally the task of CNC6 (the dark CNC in the figure indicates the signal):

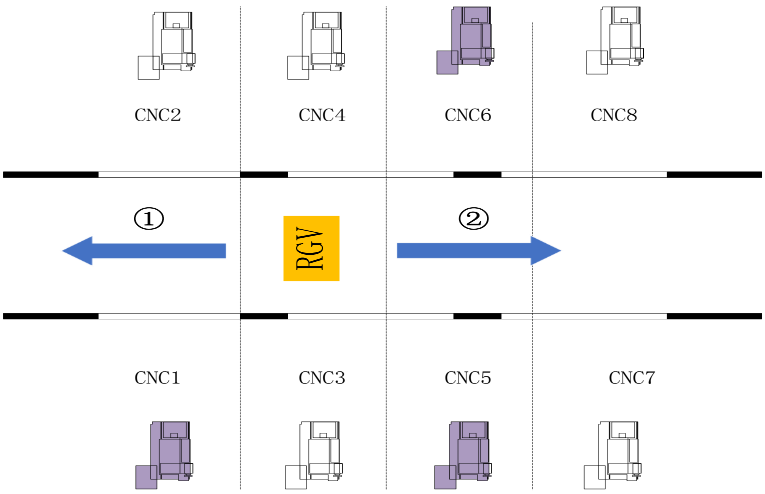

Figure 3. RGV is located in zone 2

The same is available：

(3) When RGV is in zone 3, if there is a signal around RGV, RGV will always prioritize the task on the right; if the CNC on both sides of the track sends a signal, the odd-numbered CNC will be processed first.

(4) When RGV is in position 4, the RGV movement direction defaults from right to left.

3. Model extension

The basic working environment of RGV can be divided into four situations: one process operation without failure, multiple process operations without failure, one process operation failure and multiple process operations failure.

When discussing the obstacles of multi-process operations, in the traditional research of scheduling problems, the efficiency index is often used as the evaluation index of scheduling performance [3].

However, in the actual environment, the execution of scheduling often needs to ensure the orderly production process, especially the scheduling environment with dynamic event interference. In addition to considering the general optimization objectives, the multi-process objective dynamic scheduling problem that can occur is more concerned with the difference between the pre-scheduling scheme before the uncertain factor and the re-scheduling scheme after the uncertain factor. On the one hand, it is to ensure that the pre-scheduling scheme can have certain stability, and on the other hand, it is to better guide the re-scheduling [4].

It is hoped that the scheduling has good scheduling efficiency while maintaining stable production (also called robustness). Two flexible measure indicators are proposed for flexible job shop scheduling schemes considering machine failures: the maximum completion time deviation between the initial schedule and the actual schedule, the idle time and workload ratio of each machine. It is pointed out that predicting machine failure and repair time and ensuring that each machine has a certain idle time can reduce the delay of the construction due to machine failure [5].

How to balance the two aspects of scheduling efficiency and scheduling stability is the key to solving the dynamic scheduling problem [6].

4. Summary

This paper calculates the optimal path based on the Dijkstra algorithm, embodying the analogy of time and space. In the study of RGV in the operation of a shift, the DP algorithm is used to process the process, and a series of decisions are used to generate the global optimal solution, which improves the accuracy of the algorithm.

In general, the idea of solving this problem is from simple to complex, and the idea of path optimization runs through the whole.

In the basic model of the path algorithm, fault simulation, machine ratio and position analysis process are added for different working environments, and the processing efficiency of the system is maximized under the premise of ensuring system stability, and reasonable and rapid dynamic scheduling is realized.

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