Simulation and optimization of a factory automation production line based on Plant Simulation

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Abstract. Model an automated production line in a factory in order to understand and improve the automated production line. The layout and function of this automated production line were simulated on Plant Simulation, and the statistical results were obtained according to the actual situation. According to the results, the shortcomings of the production line were analyzed, an optimization method was proposed, and the results were simulated again by using genetic algorithm for comparison.

1. Introduction

Manufacturing industry is an industry that provides all kinds of tools, industrial products and products for human life through manufacturing means. Manufacturing Industry has an important proportion in the national economy, which can reflect the level of national productivity. With the progress of science and technology and the rapid development of economy, traditional manufacturing enterprises are facing more and more severe challenges. At present, the manufacturing industry has gradually changed from the manufacturing mode of large quantity, few varieties and flowing water to the agile manufacturing mode of small quantity, many varieties and high flexibility [1], paying more and more attention to the diversity of products and the interrelation and restraint between different product processes.

The automatic production line of a factory analyzed in this paper is the multi-variety and low-batch production mode. In the manufacturing workshop, in the production and manufacturing process of products, time is often lost in waiting, handling, maintenance and other activities that cannot produce benefits, and the effective running time of many equipment is often very low. The performance of production scheduling algorithm affects the operation efficiency and product output of workshop production, which has been paid much attention by relevant researchers. As an interdisciplinary subject, production scheduling problems related to resource allocation and optimization methods have attracted extensive attention from computer fields, control technology, engineering science, communication, artificial intelligence and other disciplines [2]. This paper uses Plant Simulation to simulate [3], analyze the simulation data, and then optimize it by using the production scheduling algorithm.
2. Basic layout and production process of an automatic production line in a factory

2.1. Basic layout analysis
According to the site conditions, the production line has a total of 14 processing equipment, an automatic conveyor belt and a number of robots, which are divided into raw material distribution area, transportation area, production and processing area and cache area, among which the cache is divided into the total cache area and its cache area.

2.2. Production process analysis
An automated production line in a factory produces seven different types of products, and each pair of processing equipment processes one type of product in the processing area. In the transportation area, raw materials are transported to these processing equipment by automatic conveyors. There is a cache area next to each processing area. When the processing is completed, the finished products are first stored in the cache area of each two devices, and then moved to the automatic conveyor belt and transported to the total cache area.

2.2.1. Raw material distribution area process
According to seven different raw materials each time in sequence, the quantity of each time is 1 piece.

2.2.2. Transit zone flow
The raw materials are put on the automatic conveyor belt. According to the different types of raw materials, the corresponding raw materials are discharged after passing through the corresponding processing area. When passing through the different cache area, the finished products are put on the conveyor belt and transported to the total cache area.

2.2.3. Production and processing zone flow
The raw materials are transferred to the corresponding stations in the transportation area, and semi-finished products are obtained after the initial processing by the first processing equipment in each processing area. The semi-finished products are taken out by the first robot and put into the second processing equipment for processing, and then taken out and put into the cache area by the second robot after completion.

2.2.4. Cache flow
The cache is divided into the total cache area and the cache area. The respective cache area caches seven different types of finished products, and the total cache area caches all processed products.

3. Establishment of simulation model

3.1. Raw material distribution design
According to the raw material release area process, design the initial order, as shown in Figure 1. There are four columns in the table, namely, the source of raw materials, the quantity of raw materials produced, the name of raw materials (product 1, product 2, product 3, product 4, product 5, product 6, product 7), and the details of raw materials (arrival destination).
3.2. Transport area design
According to the transportation area process, design the conveyor belt, set up different sensor positions on the conveyor belt, and distribute to different processing areas according to different raw materials. Use defined methods in different locations and use Simtalk language to implement programming for settings.

3.3. Processing and production area design
According to the process of the processing and production area, set the time for processing equipment to process products. Then set up the picking method of the first robot in the processing area, get the corresponding raw materials placed in the first buffer area, put them into the first processing equipment for processing, and then take them out and place them on the second processing equipment for processing. Then set the picking method of the second robot in the processing area, put the products processed by the second processing equipment on the conveyor belt.

3.4. Cache area design
According to the buffer area process, set the capacity of the sub-buffer area. Place a total buffer area at the end of the conveyor belt, so that all finished products are put into the total buffer area.

4. Simulation model operation and analysis
4.1. Simulation model running
Open the simulation runner, set the duration to 24 hours, start to run the established model, and the simulation run is shown in Figure 2.
4.2. Simulation result analysis
After the simulation model runs, you can open Chart to see the corresponding statistical data, as shown in Figure 3. The total number of products obtained in the total buffer area within 24 hours and the number of products of each type are shown in Figure 4.

According to Figure 3, it can be seen that Station6 and Station8 have serious blockages, and the corresponding processing product types of these two devices are product 1 and product 2. According to Figure 4, it can be seen that the quantity of product 1 is the least, and product 2 and product 3 are also less than other types of products. According to the production layout and the distribution order and quantity of raw materials, the reason for these two results is that the areas where products 1, 2, and 3 are produced are closer to the distribution point than other products, but the order of distribution is still in the order of 1-7. Distribute and distribute the same quantity each time, so the production areas of products 1 and 2 cause serious congestion, lower production efficiency and lower output.

5. Simulation and optimization of automated production line

5.1. Simulation optimization method
According to the analysis obtained from the results, the distribution order of raw materials is changed. This article uses genetic algorithm to optimize this. The genetic algorithm is a global optimization algorithm that is modeled on Darwin's bio-evolution theory of "natural selection, survival of the fittest" and Mendel's genetic law to find the optimal solution. According to the genetic and mutation
phenomena of chromosomes in the process of life genetic evolution, operators are constructed to iteratively find the optimal solution. Abstract The process of biological evolution and inheritance is selection, crossover, and mutation, and iteratively finds the best adapted chromosome as the optimal solution[4].

Starting from a population of the potential solution set for solving the problem in generations, a chromosome code represents an individual. Through selection, crossover, and mutation operations, the population is constantly updated in the iterative process, the optimal value of the objective function for the problem is obtained in the judgment of the fitness of the individual, and the approximate optimal solution for the generational solution problem is obtained [5].

5.2. Simulation optimization model establishment
According to the results obtained by the genetic algorithm, the distribution order of different types of product raw materials is set, as shown in Figure 5.

5.3. Simulation optimization model operation
Run the optimized model again, and the statistical results are shown in Figure 6. It can be seen that, compared with the previous model, products 1 and 2 are no longer blocked, and the final total output has increased, and the number of products of each type has increased, which has optimized the production line.

6. Conclusion
Use plant simulation to simulate the automated production line of a factory, design the raw material distribution area, transportation area, production processing area, and buffer area, so that the
production line can produce products according to the actual production, and finally get the operating results through the form of 3D charts. The statistical data can be seen more intuitively. Through the analysis of the result data, the problem of the production line was found, the method to improve it was proposed, and the optimized model was established again, and the result data obtained twice was compared to confirm that the production line was optimized.

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