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Production Planning and Scheduling Assembly Simulation Based on VR Technology

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Abstract: The operating mode of the traditional manufacturing industry is "design-manufacture-test-operate". With the development of virtual reality technology and 3D modeling technology, 3D modeling software can be used to build 1:1 models before traditional assembly operations. Combine VR technology to simulate the assembly process of physical objects. By applying collision detection technology to predict the feasibility of the assembly path in the virtual assembly process, experts can exchange professional knowledge more immersively and intuitively in the virtual environment, and predict design defects. This has become a hot spot for enterprises and research institutes. Based on this, this paper studies the ship block assembly simulation based on VR technology. This article uses modeling software to construct the 3D model required for assembly simulation, and imports the model into the virtual reality development software to build a virtual manufacturing scene; then the digital prototype ship model constructed by professional ship design software is delivered in segments The details are optimized in the 3D modeling software to turn it into a realistic simulation model and imported into the virtual reality development software. This paper establishes the model of work shift formation and assignment model of work shift group. Then, the genetic algorithm that is often used to solve the problem of shop scheduling is improved, and a solution method based on the adaptive simulated annealing genetic algorithm is proposed for the fixed object pipeline model. In this paper, the Petri net model is used to study the problem of the scheduling machine failure of the hybrid flow shop, and the Petri net-based simulation model is established by using the dynamic simulation characteristics of the Petri net. Experimental research shows that the maximum completion time obtained by using the improved accelerated particle swarm algorithm is 20 hours. The improved accelerated particle swarm algorithm proposed in this paper has better convergence than the standard particle swarm algorithm and accelerated particle swarm algorithm.

1. Introduction

With the rapid development of high-tech technologies such as computer technology and communication technology, market competition has transformed from local competition to global competition. Use the computer to plan the assembly sequence, formulate a unified evaluation standard, and avoid the loss of good assembly plan and the waste of assembly cost and time. The optimal assembly sequence is selected through the assembly sequence evaluation, and the product assembly sequence, assembly process and maintainability are virtualized on the virtual platform. This is for companies to improve product design, ensure assembly feasibility, increase assembly efficiency, and reduce Assembling costs, shortening the product development cycle, and improving the market competitiveness of products are of great significance.

The assembly simulation of industrial manufacturing is displayed in the form of virtual reality, that is, virtual assembly. Foreign research started earlier, and with the strong support of the government, foreign scholars have proposed many research methods for virtual assembly. For example, Nanyun has carried out pioneering research in assembly sequence planning, and proposed the concept of assembly sequence priority relationship and the assembly association diagram model. The assembly priority relationship refers to the assembly sequence relationship between a certain group of parts in the assembly, so obtaining this priority constraint relationship and expressing it explicitly is the most intuitive method of assembly sequence generation [1]. Arata designed an algorithm on the basis of the assembly association diagram, which uses the assembly association diagram as input information. Through the analysis of the association diagram, a series of questions are generated. The user will answer the human-computer interaction according to the geometric structure information of the assembly. According to the user’s answer, all geometrically feasible assembly sequences are deduced [2]. Silva changed the way of asking questions and reduced the number of questions asked to users. The question they designed is not in the form of "Yes-No", but requires the user to exhaustively list all the assembly priority relations of each assembly connection after reasoning and predicting the product assembly structure [3].

In the research of Chinese scholars based on VR technology in production planning and scheduling assembly simulation application, Nan proposed a method to solve assembly sequence generation by matching conditions. This method forms a component hierarchy diagram from the geometric model of the assembly and the component matching diagram. According to the assembly priority relationship between the parent and child nodes in the component hierarchy diagram and the interference constraint relationship in the same layer nodes, the subsequent traversal is obtained from the bottom Upward assembly sequence [4]. Lu researched the method of free movement model and restraint model, using equipment with force feedback effect, so that users have the feeling of force feedback when performing virtual assembly, and increase the immersion of virtual assembly [5]. In the research of CAD method based on virtual reality, Ping proposed to simulate through "user-guided disassembly and assembly", so as to obtain the correct assembly sequence and assembly path of the parts [6].

This paper constructs a virtual simulation scenario of segmented manufacturing. Investigate the actual shipyard, refer to the main production sites of the shipyard, such as the segmented manufacturing infield, the general assembly site, etc., based on the existing modeling experience, construct the virtual scenes of the segmented manufacturing infield and the general assembly site. This paper uses Flexsim software to simulate and verify the fixed object pipeline scheduling problem, and also proves the effectiveness of the algorithm in this paper. This paper uses Petri nets to have a good ability to simulate the dynamic characteristics of production scheduling problems, and establishes a Petri net machining model without failure and a Petri net machining model that may fail. Under different fault conditions, use Petri net model to simulate different production scheduling schemes.

2. Application and Research of Production Planning and Scheduling Assembly Simulation Based on VR Technology

2.1. Build a Virtual Scene in the Unity 3D Engine

(1) Import of 3D model and texture map

Open the Unity 3D program, create a new project named "Assemble", and create a folder named "Model_FBX" in the Project panel. This folder is used to save the imported FBX model files and model texture files. In the process of model making, the textures used are saved in the Texture file. Copy and paste this file in Model_FBX. Copy and paste the FBX model files named Field1 and Field2 to the Model_FBX file. Unity 3D will automatically import the model and generate the model's Prefab (prefab) and the corresponding shader file. The shader file is automatically based on the model's texture map. The generated file is named "Materials". The texture used in the shader is the corresponding texture file in Texture. This process is automatically matched by Unity 3D. Note that you cannot change the name of the texture at will, otherwise the texture will not be found. For problems like this, the naming of the texture files should also be in English. The texture may be lost during the import process, so you can manually assign the texture to the shader [7-8].

(2) Add lights and sky balls

Unity 3D uses the industry-leading real-time lighting technology Enlighten in lighting special effects. Enlighten real-time lighting technology is a simulation based on the physical characteristics of light transmission, which can make the scene look more real, rich and colorful with less hardware performance consumption. More three-dimensional.

In the Assemble project, create a folder named Scenes in the Project panel. This folder is used to save scene files. Create a new scene named MainScene. Drag the two presets Field1 and Field2 into the Hierarchy panel. By default, the newly created scene will have two game objects: Main Camera and Directional Light. The Main Camera is equivalent to the "eyes" that observe the scene. What the "eyes" see will be displayed in the Game view, and the Directional Light is equivalent to the "sun" in the scene. It enhances the brightness of the entire scene. In the interior of the workshop, in order to make some models brighter and display better, you can add Point light, which emits light from a point as the center to enhance the brightness of surrounding models.

2.2. Fixed Object Pipeline Simulation Based on Flexsim

(1) Discrete system simulation and its application in shipbuilding workshop

The steps of discrete system simulation can be divided into several steps such as system investigation, building simulation model, designing simulation program, running simulation model, simulation data analysis and simulation result output [9-10]. System research is the understanding and cognition of the system, including the three aspects of system structure, system process and related parameters; building a simulation model includes defining state variables, defining system events and related attributes, activities and processes, and design policy and clock advancement methods The design of simulation program is based on the simulation model, and the simulation language, related parameters and module division of the simulation program are designed.

(2) Simulation process

Take plan one as an example. Place 6 sections in the field in the form of 3×2, namely section 1, section 2, section 3, section 4, section 5 and section 6, in the same row The two adjacent sections are 10 meters apart, and the two sections in the same column are 20 meters apart, thus dividing a 20×20 site [11]. The green area in the middle of the site is the rest area, and the unworked work teams will stay in the rest area. Set up a network node for each segment and rest area, and connect the network node of each segment with the network node of the rest area, which represents the movement path of the worker. When the work crew stays in a certain section, it means that the work crew is processing the section, and when the work crew stays in the middle waiting area, it means that the work crew is in the non-working stage.

2.3. Main Improvements of Particle Swarm Algorithm

The improvement of particle swarm algorithm mainly includes the following aspects:

(1) Improve particle speed and speed update formula

The typical algorithm is a discrete binary algorithm. In solving discrete and combinatorial optimization problems, the particle speed and position equations are improved to adapt to the discrete problem. This paper proposes a discrete binary particle swarm algorithm to solve combinatorial optimization problems. Its speed and position formula are as follows:

$$v_{ij}(t+1) = v_{ij}(t) + c_1 r_1(t)\left(p_{ij}(t) - x_{ij}(t)\right) + c_2 r_2(t)(p_{gj}(t) - x_{ij}(t)) \quad (1)$$

$$\text{if} \;\; p_{ij} < sig\left(v_{ij}(t+1)\right) \;\; \text{then} \;\; v_{ij}(t+1) = 1 (2)$$

$$\text{else} \;\; v_{ij}(t+1) = 0 (3)$$

Where $sig\left(v_{ij}(t+1)\right) = \frac{1}{1+\exp(-v_{ij}(t+1))}$ is the sig mod function $p_{ij} \in [0,1]$ is a random vector.

(2) Effective fusion of particle swarm algorithm and other algorithms

The typical representative is the hybrid particle swarm algorithm. The hybrid algorithm mainly uses the tournament selection method in the evolutionary algorithm. Using this method significantly improves the algorithm's convergence speed and global search ability [12-13].

(3) Make particles more intelligent

The typical algorithm is the immune particle swarm algorithm. The idea of the algorithm comes from the immune system possessed by creatures in nature, which can allow the body to recognize self and non-self [14-15]. The diversity characteristics of the immune system and the immune memory characteristics are effectively integrated into the particle swarm algorithm, and the immune particle swarm algorithm is proposed, which improves the global search performance of particles; the introduction of the information processing mechanism of the immune system improves the performance of the particle swarm algorithm. Convergence accuracy and convergence speed.

(4) Change the topological structure of the particle population

The typical algorithm is a particle swarm algorithm based on domain operators. Researchers have found in the research domain operator that the particle swarm algorithm can significantly improve the performance of the algorithm after adding this method, and can prevent particles from falling into local extreme values. When Suganthan joins the variable domain operator, the random walk of the particle swarm algorithm and the gradual adjustment of the inertia weight allow the particles to adapt to a better search for the optimal value [16-17].

(5) Propose the concept of multiple particles and multiple groups

The diversity of particle populations ensures the diversity of particle activities in the search space. Among the many improvement strategies, they can be summarized into two categories: feedforward and feedback [18-19]. Feedforward guarantees the one-way transmission of information. Feedback is the use of diversity measurement function to feed back population diversity. When studying population diversity, the main considerations are population distribution entropy and average particle distance. The population distribution entropy represents the distribution of particles in each area divided by the population in the search space, and the average particle distance represents the discrete distribution of each particle in the population. The specific representation is as follows:

1) Population distribution entropy:

When the population is initialized, it is necessary to ensure the random distribution of individuals. In order to make the particle distribution uniform, the expression defining the population distribution entropy E(t) is as follows:

$$E(t) = -\sum_{i=1}^{n} \frac{z_i}{N} \ln \frac{z_i}{N} \quad (4)$$

n represents the number of subspaces divided into the search space, N represents the number of particles in the entire population, and z_i is the number of particles in the subspace, where i=1,2...n. When E() is smaller, it means that the distribution of the population is not uniform [20-21].

2) Average grain distance:

In order to quantitatively study the state of the population, this article defines an average grain distance of 8(t), and the corresponding expression is as follows:

$$\delta(t) = \frac{1}{L*S} \sum_{i=1}^{s} \sqrt{\sum_{j=1}^{D} (x_{ij}^{t} - \overline{x_j^t})^2} \quad (5)$$

Where L represents the maximum length of the diagonal in the search space, s is the number of all particles in the population, D is the dimension of the solution space, x_{ij}^{t} represents the position component of the i-th particle of the t generation in the i-dimensional space, $\overline{x_j^t}$ is the mean value of the position of all particles of the i-th generation in the i-th dimension space. When 8(t) is smaller, the population distribution is more concentrated.

The above improvements have expanded the application field of the particle swarm algorithm, improved the algorithm's convergence and convergence speed, balanced the algorithm's local space search ability and global space search ability, and improved the performance of the algorithm [22-23].

(6) Improved accelerated particle swarm algorithm

1) Speed update and improvement

The speed update formula of the accelerated particle swarm algorithm is as follows:

$$v_i^{t+1} = v_i^t + \alpha\varepsilon + \beta(p_g - x_i^t) \quad (6)$$

Where ε is a random vector uniformly distributed in [0,1], v represents the velocity of the i-th particle after the first iteration, and p is the global optimal position, in order to improve the convergence efficiency.

2) Location update and improvement

The location update rules are defined as follows:

$$x_i^{t+1} = (1-\beta)x_i^t + \beta p_g + \alpha\varepsilon \quad (7)$$

The update rule of the position formula is mainly to increase the overall convergence of the algorithm. In the two improved update formulas, a large number of studies have shown that a =0.1L~0.5L, where L is the scale of each variable, β ∈[0.1,0.7], suitable for most optimization problems. The accelerated particle swarm algorithm is only a single equation about the position variable in the particle position update, so there is no need to deal with speed. In the beginning of the iterative process, random variables are removed as a further improvement of the accelerated particle swarm algorithm, which is achieved by introducing a monotonically decreasing a parameter. The specific equation is as follows:

$$\alpha = \alpha_0 e^{-\gamma t} \quad \text{or} \quad \alpha = \alpha_0 \gamma^t \tag{8}$$

Among them, $\alpha_0 = 0.5 \sim 1$, γ is the control parameter. Although the accelerated particle swarm algorithm reduces the premature convergence of the algorithm and increases the diversity of the particle population, it does not make good use of the memory ability of individual particles to control the search for the optimal value. In the process, the balance between particle development and search is guaranteed. When encountering non-linear and multi-objective optimization problems, accelerated particle swarm optimization often leads to premature convergence due to the small number of populations [24-25]. Based on the above factors.

3) Replace the current position x_i with the current best position $p_i$of the particle, retaining the local optimal position. The best particle of all particles is used to represent the memory capacity of the particles to the target, and the type of the population is improved. The current position representation of all particles is called a search set. Let this set become a particle search space. It breaks that the particles can only search for targets in the local space and expands the search space of all particles. The obvious improvement is the area of the particles, and it can Relieve premature convergence.

2.4. Function and Interaction Design of Segmented Virtual Assembly System

The main functions and interaction methods of the segmented assembly virtual simulation system are designed as follows:

(1) Free viewing angle function of virtual assembly. The constructed virtual scene restores the basic layout of the segmented manufacturing workshop and the general group site. With the free viewing angle function of the camera, you can use the mouse to perform operations such as panning, rotating and zooming in the scene, overlooking the layout of the virtual scene, for some equipment, such as: Crane, tire frame, etc., can be observed around. For the segmented virtual assembly process, the segmented model can be seen close and far. It should be noted that a large number of mouse control cameras are required to obtain the best assembly perspective during the segmented assembly process, and the mouse wheel is used to control the camera distance segmentation. When the model is near or far, the farthest distance from the model should not exceed the top of the factory building, and it cannot stick to or pass through the model area in the nearest distance. In addition, when controlling the camera rotation, translation and distance, the speed of the camera should be appropriate. The use of this function is in the infield and general assembly scenes of segmented assembly.

The interactive mode of the free viewing angle function is designed as: the middle mouse button pans the viewing angle, the mouse wheel controls the distance and the left mouse button controls the viewing angle rotation. This function is realized by programming the camera in the scene to pan, change the distance and rotate.

(2) Virtual assembly simulation and assembly path feasibility verification function. This is the main function of the simulation system development. This part of the function mainly reflects the assembly process in the segmented assembly flowchart in the virtual scene, expresses the assembly sequence of the segmented components, the direction of the component assembly, etc., and uses collision detection technology to detect Interference problem of a certain path in the assembly process.

According to its function, the interactive mode can be designed as follows: put the component model in a list, the list can be scrolled, use the mouse to select the model part in the list, drag it to the assembly scene, and click when the model matches the assembly sequence to meet the predetermined design Direction icon button. If there is no interference from other components in this direction, the component will move to the specified position in a certain direction, otherwise it will be automatically destroyed after collision and interference. Use this method to complete the assembly of the segmented model. This interaction the method is more direct and reflects the interactive characteristics of virtual reality. In addition, a button should be placed in the scene. Click the button to browse the assembly flowchart of the segment.

(3) The total group simulation function of the ring total section. This part of the function is designed to express the process of assembling different sections into a general section in the virtual general group site. Use the mouse to click on the section to select the section name option in the drop-down menu. According to the script preset, the section model will move to the appropriate Location, click on the manufacturing process selection drop-down menu to select welding options, so as to express the simulation effect of welding in the scene.

(4) Several manufacturing process simulation functions. This part of the function mainly expresses the technological process of welding, turning over, marking, completion measurement and firework correction in the process of segmented assembly. This part of the function aims to express the technological effect. The interactive mode is designed as follows: use the form of a list, the options in the list are the names of the manufacturing processes, and use the mouse to click on the options to trigger the process actions and show them in the scene at the same time.

3. Research on Production Planning and Scheduling Assembly Experiment Based on VR Technology

3.1. Workshop Production Resource Balance

In the process of ship block production and processing, fixed-object assembly line operation is adopted, and multiple work teams perform block operations together, which is actually a parallel operation mode. In the parallel operation mode, there will be a phenomenon that multiple similar tasks are performed at the same time. At this time, each operation team may need the same resources, such as certain welding equipment or some measuring tools, etc., due to the limited and non-sharing resources Sexuality will lead to mutual influence between tasks, that is, resource conflicts. The conditions for the occurrence of resource conflicts are: a certain resource is used by multiple tasks in competition; the number of tasks applying for the resource is greater than the capacity of the resource.

3.2. Algorithm Design and Experimental Data Collection

Binary, decimal and real number coding are the main coding techniques when solving functional problems. Binary coding is the most basic and simplest coding method. It is mainly used in numerical calculations. When solving genetic algorithms for practical problems, it is difficult to directly describe the characteristics of the problem through binary means. Real number coding, as its name implies, uses a real number to represent the solution. It has a wide range of applications in complex optimization problems. Its applicability is better than binary and decimal coding methods. However, due to its own nature, its coding method requires special the design of, among them, for the mapping relationship between "chromosomes" and solutions:

(1) Any code in the code space must be mapped to a specific solution in the solution space, otherwise the code is meaningless and can be said to be illegal.

(2) After decoding the code in the code space, whether the corresponding solution is within the feasible range of the actual problem. That is the feasibility of coding.

(3) There is a mapping relationship between the coding in the coding space and the solution in

the solution space, which can be 1-to-1 mapping, N-to-1 mapping, and 1-to-N mapping. Ideally, the 1-to-1 mapping relationship is the best It is simple and clear, and the mapping of 1 to N should be avoided as much as possible.

Use related test functions to compare standard particle swarm algorithm, accelerate particle swarm algorithm, and improve the performance of accelerated particle swarm algorithm. The parameter settings are as follows: In parameter control, the x dimension is controlled in 20 dimensions, the value range of each dimension is [-200,200], 10 simulations are performed, and the number of iterations is 30 each time, and the 10 simulation results are averaged. The population size is 40, and the maximum and minimum particle velocities are limited to 100, -100 to collect experimental data.

3.3. Petri Net Establishes the Fault Model of Mixed Flow Shop

In the process of establishing the model, the processing state of the machine is mainly determined by the state change of the allocation processing of the workpiece and the resource utilization of the processing machine during the production process of the machine. Because of the state change in the entire model, there is competition for processing machine resources, synchronous processing of workpieces, etc., so Petri nets are used to build the model. In the Petri net object model, bits and state transitions have clear practical meanings. Bits include resource bits, operation bits, and storage bits.

(1) Resource bit: mainly represents the processing machine resources in the model.

(2) Operating position: indicates the processing process of the workpiece on the processing machine, mainly the time it takes to pass the processing machine.

(3) Storage location: indicates the storage of the workpiece before entering the next stage of processing after undergoing each processing procedure. In the state transition of the model, the influence of the transition time is not considered, and it is instantaneous. There are mainly processing start transition and processing end transition, indicating the beginning and end of machine processing.

4. Research and Analysis of Production Planning and Scheduling Assembly Experiment Based on VR Technology

4.1. Assembly Sequence Planning Analysis

At present, in the application of genetic algorithm, the coding method based on process is selected for common workshop scheduling problems. When solving the problem of flow shop for fixed objects, it is necessary not only to choose a reasonable processing sequence of workpieces, but also to choose a suitable processing work team. The work team can also be understood as processing resources, and it is difficult to clearly express the solution using a single coding method. Therefore, a two-layer coding scheme is proposed: the first layer is for the processing sequence of the workpiece, and the second layer is for the processing resource of the workpiece, that is, the work team. The experiment is shown in Table 1.

As shown in Table 1, a simple example of the above two-layer coding method is described. Table 1 shows the data processed by a group of 2 work pieces and 6 processes by 5 work teams. Z represents the callable work teams. There are five work teams Z1, Z2, Z3, Z4 and Z5 available for use ; J represents the workpiece, V represents the process, the processing of the workpiece 1 J needs to go through the two processing processes of V1 and 12. Among them, the first process V1 of workpiece 1 J can be processed by four work teams Z1, Z2, Z4 and Z5, and the time required is 3, 3, 7 and 2 time units respectively; the second process of workpiece 1 J V12 can be processed by four work teams, Z1, Z3, Z4 and Z5, and the time required is 5, 3, 3 and 4 time units respectively.

Set the start time of the job at 8 am, and the end time of the first plan is "Day 2, 18:0635", which means it takes 34 hours, 6 minutes and 35 seconds; because of the additional calculations of the work team's going to segment and The time to return to the rest area is slightly higher than the result calculated by mathematical methods.

Table 1. Processing data analysis

		Z1	Z2	Z3	Z4	Z5
J_1	V_{11}	4	3	4	3	2
	V_{12}	6	-	5	3	5
J_2	V_{21}	4	4	3	3	4
	V_{22}	-	4	3	-	3
J_3	V_{31}	5	2	-	-	5
	V_{32}	5	3	2	1	6

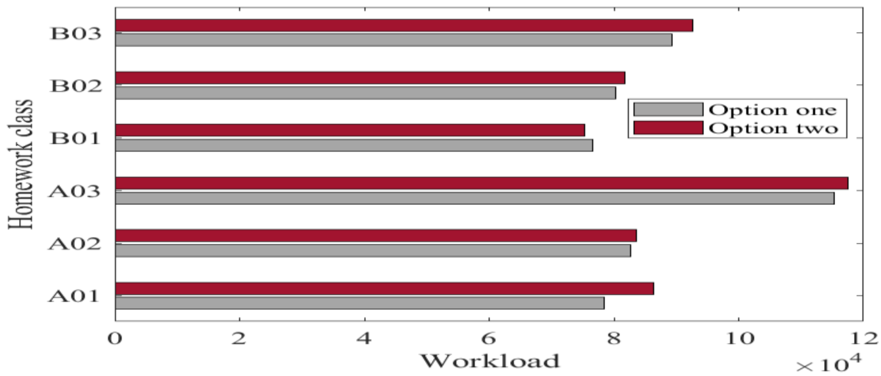

Figure 1. Working hours of each team in Scheme 1

Through the simulation, the feasibility of the first option under the condition of the shortest processing time is basically determined, and the reason for the short processing time of the first option is also more intuitively understood. If the shortest processing time is the ultimate goal, while reducing the unnecessary waiting time of the work team, it is necessary to let the work team with higher working ability take on more work. From the statistics of the simulation results, you can also visually understand the superiority and reason of the first solution.

In the second plan, the utilization rate of the A01 and B01 shifts is relatively high. Compared with the first plan, the use of the lower working team to perform more operations will inevitably increase the working time. Through the simulation, the feasibility of the first option under the condition of the shortest processing time is basically determined, and the reason for the short processing time of the first option is also more intuitively understood.

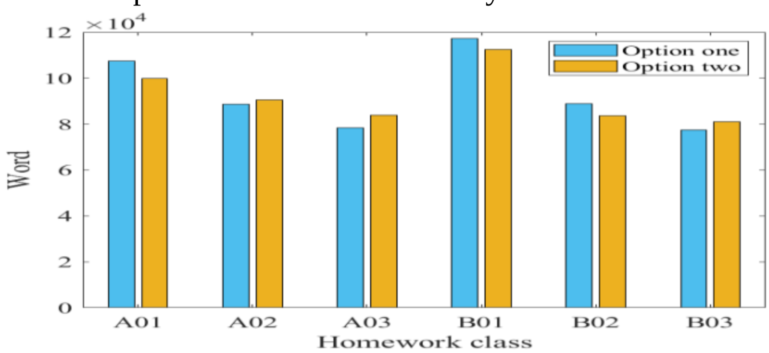

Figure 2. Working hours of each team in Scheme 2

As shown in Figure 2, if the shortest processing time is the ultimate goal, while reducing the unnecessary waiting time of the work team, it is necessary to let the work team with higher working ability take on more work. From the statistics of the simulation results, you can also visually understand the superiority and reason of the first solution.

By observing the simulation operation process and team utilization rate of Scheme 1, it can be seen that Scheme 1 makes full use of each operation group while meeting the overall requirements, and does not cause a certain operation group to be idle for a long time or overwork, which proves that the scheme is feasible Sex.

4.2. Analysis of Group Cognition Coefficient

It is expressed in the form of a Gantt chart. The Gantt chart shows the processing of all workpieces, including the starting time of each workpiece and the number of workpieces processed on each machine and the corresponding workpiece number. When all the workpieces are processed, the time used is the maximum completion time. The maximum completion time obtained by using the improved accelerated particle swarm algorithm is 20. Comparison of the convergence of the three algorithms is shown in Figure 3.

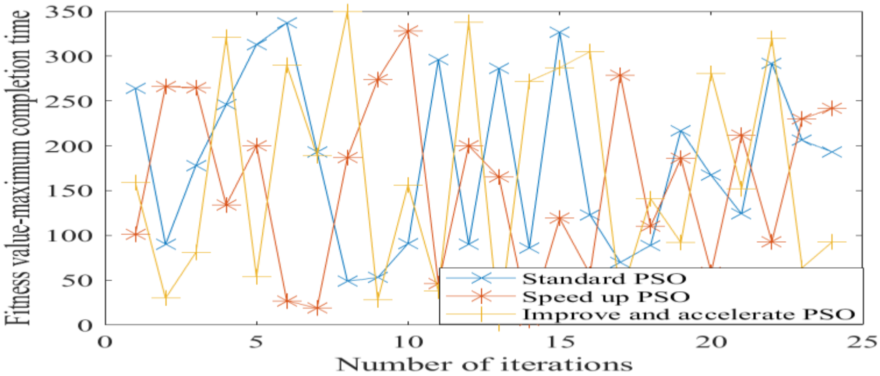

Figure 3. Comparison of convergence of three algorithms

From the above algorithm convergence graph and scheduling graph, it can be concluded that the improved accelerated particle swarm algorithm has better convergence than the standard particle swarm algorithm and accelerated particle swarm algorithm; in obtaining the optimal solution, the improved accelerated particle swarm algorithm has obvious advantages, and the A stable optimal solution can be obtained in a few iterations, while the standard particle swarm optimization and accelerated particle swarm optimization require more iterations. In the process of searching for the optimal value, the algorithm in this paper is obviously easier to find the optimal solution and the optimal solution is better than the accelerated particle swarm algorithm.

In an automobile processing workshop, there are 12 workpieces to be processed urgently, and each workpiece has to go through three processes of turning, planing, and grinding. The number of lathes in each process is 3, 2, and 4, among which the first stage machine The number is 11,12,13, the second stage machine number is 21,22, and the third stage machine number is 31,32,33,34, and each lathe is in the process of processing, the experimental results in this article use the calculation results of 10 runs The data is compared, and the experimental results are shown in Figure 4.

Compared with the 10 runs of this article, the optimal value of the algorithm in the initial search is 29, and the value in the traditional search is 30. Among the optimal search times, the traditional algorithm has searched 3 times, and the algorithm in this article has searched 5 times. Therefore, the improved accelerated particle swarm algorithm has a strong search ability. It has unique advantages for solving the mixed flow shop scheduling problem.

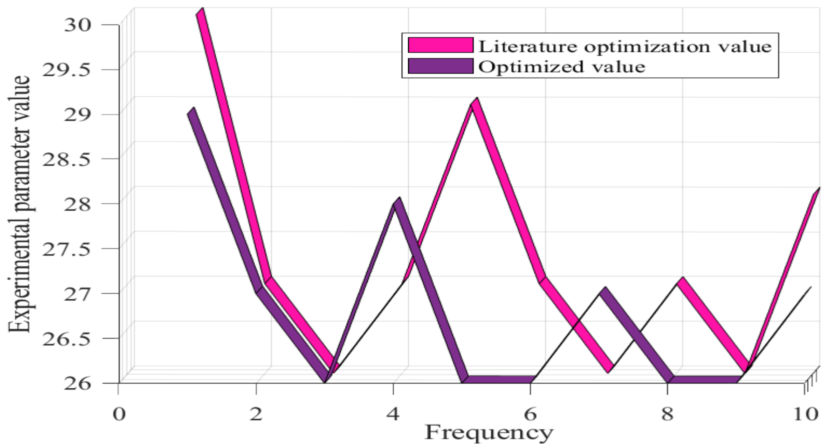

Figure 4. Results of the experiment run 10 times

5. Conclusion

This paper takes the third-order hybrid flow shop as the starting point, uses Petri nets to establish the machine model and machine failure model of the hybrid flow shop, analyzes the machine failures in the scheduling problem of the hybrid flow shop, and finds through research that the academic community uses the machine repair time and whether it can be repaired Divide faults into major faults and minor faults. By simulating the model with different machine failure problems, the production scheduling arrangement was obtained, and good results were obtained.

This paper studies the production scheduling problem of the ship block workshop and the fixed object assembly line, and uses the Flexsim software to visually simulate the scheduling scheme. Due to the limitations of personal time, ability, and knowledge, this article has some shortcomings in the research of production scheduling and simulation for hull block workshops. In the actual hull block workshop and the scheduling of fixed object assembly lines, factors that affect production scheduling There are many, such as space layout, bottleneck equipment, equipment loss, etc. Therefore, with the deepening of research, more different factors need to be considered to more accurately solve the production scheduling problem.

This paper analyzes the basic units of the model in Tribon, and clarifies the method and model characteristics of the segmented model exported from Tribon in DXF format. Through repeated verifications, the optimal parameter settings for importing the DXF model exported from Tribon software into 3D Max were obtained, and the model was optimized in 3D Max, and finally the segmented model was imported into the virtual reality development software Unity 3D.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

References

[1] Nanyun J , Hongsen Y , Automation S O , et al. Integrated optimization of production planning and scheduling for fixed-position assembly workshop with uncertain re-entrance. Computer Integrated Manufacturing Systems, 2017, 23(3):584-598.

[2] Arata, Yoshiyuki. Endogenous Business Cycles Caused by Nonconvex Costs and Interactions. Journal of Economic Interaction and Coordination, 2017, 12(2):1-25.https://doi.org/10.1007/s11403-015-0169-1

[3] Silva B J V D , Morabito R . Planning of an aeronautical structural assembly of jets using project scheduling approach with constrained resources and multiple modes. Gesto & Produo, 2015, 22(2):254-266.

[4] Nan-Yun J , Hong-Sen Y , Automation S O , et al. Integrated optimization of production planning and scheduling for fixedposition assembly workshop with rework. Control and Decision, 2017, 23(3):584-598.

[5] Lu H , He L , Huang G Q , et al. Development and comparison of multiple genetic algorithms and heuristics for assembly production planning. Ima Journal of Management Mathematics, 2016, 27(2):181-200.https://doi.org/10.1093/imaman/dpu016

[6] Ping X G . Business process reengineering — A case study. Computers & Industrial Engineering, 2016, 29(1-4):367-369.https://doi.org/10.1016/0360-8352(95)00100-F

[7] Wang B , Guan Z , Ullah S , et al. Simultaneous order scheduling and mixed-model sequencing in assemble-to-order production environment: a multi-objective hybrid artificial bee colony algorithm. Journal of Intelligent Manufacturing, 2017, 28(2):419-436.https://doi.org/10.1007/s10845-014-0988-2

[8] Xie C , Allen T T . Simulation and experimental design methods for job shop scheduling with material handling: a survey. The International Journal of Advanced Manufacturing Technology, 2015, 80(1-4):233-243.https://doi.org/10.1007/s00170-015-6981-x

[9] M'Hallah R , Alhajraf A . Ant colony systems for the single-machine total weighted earliness tardiness scheduling problem. Journal of Scheduling, 2016, 19(2):191-205.https://doi.org/10.1007/s10951-015-0429-x

[10] Borreguero-Sanchidrian T , Pulido R , Garcia-Sanchez A , et al. Flexible Job Shop Scheduling with Operators in Aeronautical Manufacturing: a Case Study. IEEE Access, 2017, PP(99):1-1.

[11] Chakrabortty R K , Hasin A A , Sarker R A , et al. A possibilistic environment based particle swarm optimization for aggregate production planning. Computers & Industrial Engineering, 2015, 88(OCT.):366-377.https://doi.org/10.1016/j.cie.2015.07.021

[12] Fattahi P , Rad N B , Daneshamooz F , et al. A new hybrid particle swarm optimization and parallel variable neighborhood search algorithm for flexible job shop scheduling with assembly process. Assembly Automation, 2020, 40(3):419-432.https://doi.org/10.1108/AA-11-2018-0178

[13] Tan Q , Tong Y , Wu S , et al. Modeling, planning, and scheduling of shop-floor assembly process with dynamic cyber-physical interactions: a case study for CPS-based smart industrial robot production. The International Journal of Advanced Manufacturing Technology, 2019, 105(9):3979-3989.https://doi.org/10.1007/s00170-019-03940-7

[14] D?Rmer J , Günther, Hans-Otto, Gujjula R . Master production scheduling and sequencing at mixed-model assembly lines in the automotive industry. Flexible Services & Manufacturing Journal, 2015, 27(1):1-29.https://doi.org/10.1007/s10696-013-9173-8

[15] Camci, Fatih. Maintenance scheduling of geographically distributed assets with prognostics information. European Journal of Operational Research, 2015, 245(2):506-516.https://doi.org/10.1016/j.ejor.2015.03.023

[16] Soltani S A , Karimi B . Cyclic hybrid flow shop scheduling problem with limited buffers and machine eligibility constraints. The International Journal of Advanced Manufacturing Technology, 2015, 76(9-12):1739-1755.https://doi.org/10.1007/s00170-014-6343-0

[17] Noroozi A , Mokhtari H . Scheduling of printed circuit board (PCB) assembly systems with heterogeneous processors using simulation-based intelligent optimization methods. Neural Computing & Applications, 2015, 26(4):857-873.https://doi.org/10.1007/s00521-014-1765-z

[18] Zacharia P T , Tsirkas S A , Kabouridis G , et al. Planning the construction process of a robotic arm using a genetic algorithm. The International Journal of Advanced Manufacturing Technology, 2015, 79(5-8):1293-1302.https://doi.org/10.1007/s00170-015-6923-7

[19] Lambert S L , Calvasina R , Bee S , et al. Assembly FG: An Educational Case on MRP II Integrated within ERP. Accounting Perspectives, 2017, 16(1):43-62.https://doi.org/10.1111/1911-3838.12136

[20] Sudo Y , Matsuda M . Autonomous Assembly Process Planning According to the Production Line Configuration. International Journal of Automation Technology, 2015, 9(3):261-269.https://doi.org/10.20965/ijat.2015.p0261

[21] Hur Y , Bard J F , Chacon R . Hierarchy machine set-up for multi-pass lot scheduling at semiconductor assembly and test facilities. International Journal of Production Research, 2019, 57(13-14):4351-4370.https://doi.org/10.1080/00207543.2017.1380327

[22] Samaranayake P , Laosirihongthong T . Production planning and scheduling using integrated data structures in ERP: Implementation and numerical simulation. International journal of management science and engineering management, 2015, 10(3):176-190.https://doi.org/10.1080/17509653.2014.939726

[23] Mar-Ortiz J , Adenso-Díaz, Belarmino, González-Velarde, José Luis. A comparison of manufacturing and disassembly systems from a cellular configuration point of view. The International Journal of Advanced Manufacturing Technology, 2015, 79(9-12):2003-2016.https://doi.org/10.1007/s00170-015-6969-6

[24] Hassani Z I M , Barkany A E , Darcherif A M , et al. Planning and scheduling problems of production systems: review, classification and opportunities. International Journal of Productivity and Quality Management, 2019, 28(3):372-.https://doi.org/10.1504/IJPQM.2019.103520

[25] Kumar D , Chen Y , Esmaili A . Inclusion of Long-term Production Planning/Scheduling into Real-time Optimization. Ifac Papersonline, 2015, 48(8):229-233.https://doi.org/10.1016/j.ifacol.2015.08.186