Design of Precision Box-like Flexible Manufacturing System Based on Symmetric Differential Algorithm

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Abstract: The global manufacturing model is changing, and the manufacture of precision box parts is developing in the direction of automation and flexibility. Through the application of the information integration management module, integrated device information is collected to develop the system operation plan, which is transferred to the logistics management module and converted into control information executable by the processing module. Finally, the flexible machining of precision box parts is automatically implemented. Through the dynamic scheduling optimization strategy based on filtered directed search, the dynamic scheduling of system processing is completed. The machining target segmentation method based on symmetric differential algorithm is used to accurately extract the contour information of the precision machining target of the box. This process is the working principle of the precision box-like flexible manufacturing system based on the symmetric differential algorithm designed in this paper. The results show that the system can effectively reduce the number of marks and the maximum completion time of the processing of precision box parts, and its balance ability and processing efficiency are fast.

Keywords: symmetricdifferential, precision box, flexible manufacturing, logistics control, dynamic scheduling.

Tob Regul Sci.™ 2021;7(5): 2260-2274
DOI: doi.org/10.18001/TRS.7.5.139

INTRODUCTION

With the fierce competition in the market, enterprises are facing increasing competition pressure in the market [1]. In order to respond quickly to market changes and control costs and quality, the entire plant's production processes and automation control systems need to be integrated into the unified information management platform to form the integrated management and control automation management system. At present, the market competition faced by Chinese enterprises is intensifying. In order to effectively adapt to the changes in this environment, enterprises are forced to replace the single large-scale production methods of products with the production flexibility strategy of producing diversified products, and enhance the market adaptability and competitiveness of enterprises. For the traditional machinery manufacturing industry, the diversification and serialization of products poses a severe challenge to the delivery time and production cost of the enterprise. Can an enterprise switch from one product production to another in a fast and low-cost manner, can it produce a variety of different products with the same equipment, and the equipment can adapt to new products with market demand changes? Production enables companies to dynamically adapt to diverse needs. It is precisely because of such market competition demand that more and more machinery manufacturers in China purchase flexible manufacturing systems for automated processing of small and medium-sized complex parts [2]. The Flexible Manufacture System (FMS) refers to an automated manufacturing system consisting of CNC machining equipment, material storage and transportation equipment, and computer control systems. It includes a plurality of flexible manufacturing units that can be quickly adjusted according to changes in manufacturing tasks or production environments, and are suitable for medium and small batch production of multiple varieties [3]. According to United Nations statistics, there were 1,500 FMSs in the world in 1990, and they were mainly distributed in industrialized countries such as Japan, the United States, and the United Kingdom. The R&D application of FMS in China started late. In 1985, Beijing Machine Tool Research Institute introduced the first set of FMS (JCS-FMS-1) from Japan FANUC, which is mainly used for rotating body processing [4].

The precision box-like flexible manufacturing system based on the symmetric differential algorithm designed in this paper is used in the precision box parts processing industry. The system software adopts the dynamic scheduling optimization strategy of the precision box type flexible manufacturing system based on the filtered orientation search and the processing target segmentation method based on the symmetric difference algorithm from the two aspects of scheduling and target segmentation to improve the processing efficiency and quality of the system.

MATERIALS AND METHODS

System Hardware Design

The precision box type flexible manufacturing system based on the symmetric difference algorithm is equipped with Siemens 840D numerical control systems and PLC system, adopts PROFIBUS-DP communication protocol and more optimized PROFIBUS-S7 communication mode, and embedded Ethernet interface. The main function of PROFIBUS-DP network communication is to solve the transmission and communication of the signal of the logistics control module, which requires high real-time and accuracy of the network [5-7]. PROFIBUS-S7 is based on the principle of master-slave. This paper adopts a single-master network configuration structure.

The hardware consists of information integration management module, logistics management module and processing module. The logistics control management module is the control interface of the other two modules. It formulates the operation plan of the system according to the information integration management module, and transforms the plan into the control information executable by the processing module. According to this, the machining task is automatically completed in the machining module. The structure of the precision box-like flexible manufacturing system based on the symmetric difference algorithm is shown in Fig. 1.

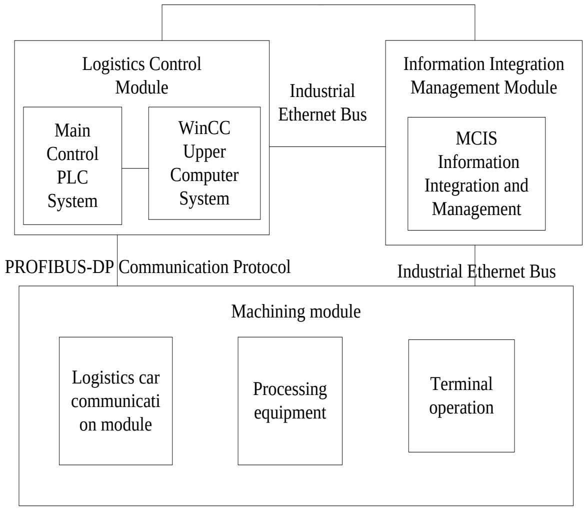

Figure 1. Based on symmetric difference precision box type flexible manufacturing system structure graph algorithm

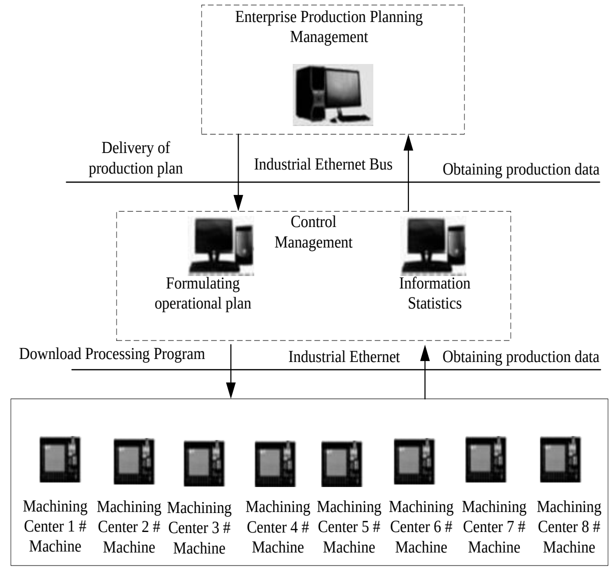

Figure 2. Integrated information management module structure diagram

a. Information Integration Management Module

The information integration management module includes PCIS, industrial Ethernet switch, firewall, network version, and single-machine version of the MCIS software package to form the information integration management module. Its main task is to collect integrated equipment information, develop system operation plan and equipment production information, tool information, diagnostic information, program management information, etc., as shown in Fig. 2.

b. Logistics Control Module

The logistics control module is divided into operational planning, operational scheduling, and operational control. Each layer can receive real-time feedback from the field within a certain range. The impact of real-time working conditions on the superior plan is gradually strengthened from top to bottom, and the task content is gradually formed. This gradual process combines the planning and randomness of logistics control skillfully and naturally [8]. The operation plan only arranges the execution order of the transportation tasks; the operation scheduling adds coordination function to the tasks with uncertain delays. Both layers belong to the macro management of logistics control, and there is still a great deal of freedom in the microscopic sense of the handling department. The system design logistics management module is based on the layer-by-layer refinement as the basic idea, that is, the task classification, as shown in Fig. 2, the division principles and methods of the A, B, C, and D tasks. It supports the efficient and automatic operation of the processing system and realizes flexible control of the production plan of precision box parts [9].

The structure diagram of the logistics control module is described in Fig. 3.

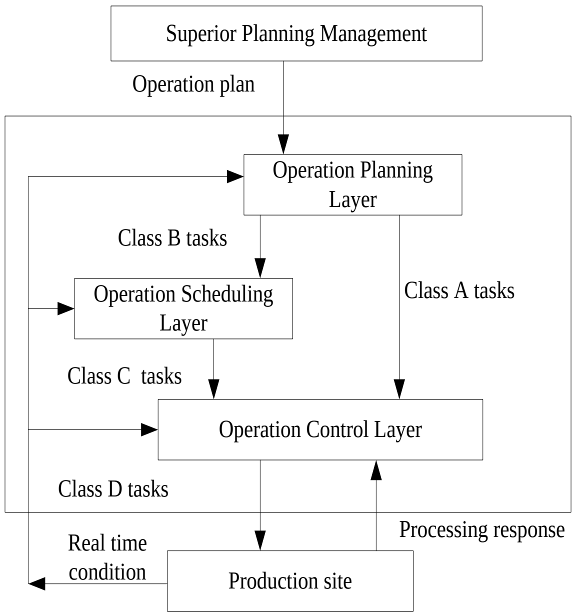

Figure 3. Flow control module structure diagram

c. Processing module

The hardware and software settings of all processing units in the processing module are constructed according to the characteristics of the overall system modular structure. The processing unit hardware setting is connected to the logistics control module through the field bus and configuration software configuration, so as to coordinate the hardware configuration and network communication to complete the processing task [10-13]. The overall structure of the processing module is described in Fig. 4.

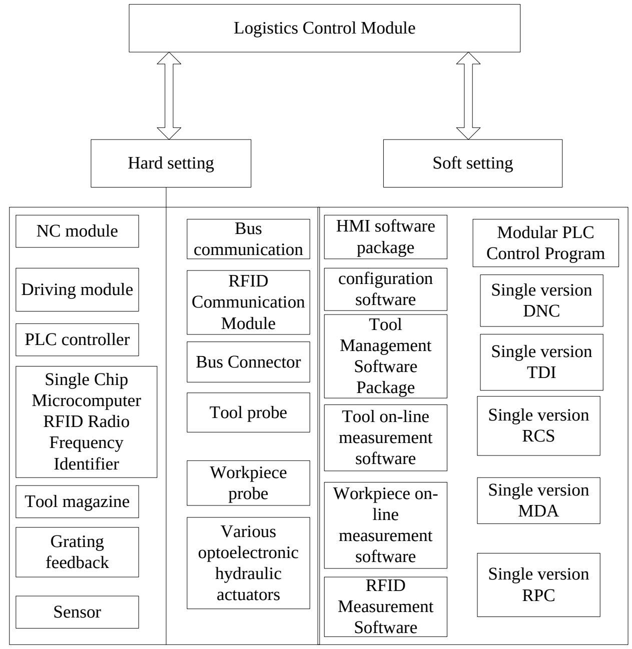

Figure 4. Processing module structure diagram

System Software Design

Dynamic Scheduling Optimization Strategy based on Filtered Directed Search

A. Filter targeted search

Filtering directed search is a directed search method that applies a filtering mechanism, which is the improvement of the branch and bound method [14-16]. The directed search method selects the most promising b nodes (directed search node) from each layer of the search tree as the nodes of the next layer extension, and the other nodes will be deleted. When selecting a directional search node from all nodes, an evaluation method is needed to determine the performance of each node [17-20]. The evaluation method can adopt global evaluation and partial evaluation. The global evaluation uses the global evaluation function to perform a complete scheduling evaluation on the local scheduling represented by the node; the local evaluation uses the local evaluation function to evaluate the current local scheduling represented by the node. The local evaluation speed is fast, but the solution with excellent performance may be lost; the more nodes participating in the global evaluation, the better the local scheduling optimization represented by the selected directional search nodes, but the calculation amount is large. In order to balance both computational complexity and search efficiency, the filtered directed search algorithm uses a filtering mechanism to weigh the above two evaluation methods. The basic principles are in formula: Local evaluation is performed on all candidate nodes, and the best performing f (directional filtering width) nodes are selected for global evaluation, and other nodes will be permanently deleted, as shown in Fig. 5. When the directed search node of layer 1 is determined, each directed search node acts as a branch of the search tree (b=2, so there are 2 branches). Since f = 2, the nodes in each branch are globally evaluated by two nodes after local evaluation to determine one directed search node. Each branch will eventually produce a complete local scheduling solution. The optimal solution will be the one with the best target solution in the complete local scheduling solution for each branch. Since the local evaluation and the global evaluation of each node are performed independently and in parallel, the search efficiency is improved; in the search tree, the number of branches and the global evaluation number of each node are determined, so the search space and the calculation amount are reduced. Thus, the scheduling optimization solution can be obtained quickly [21].

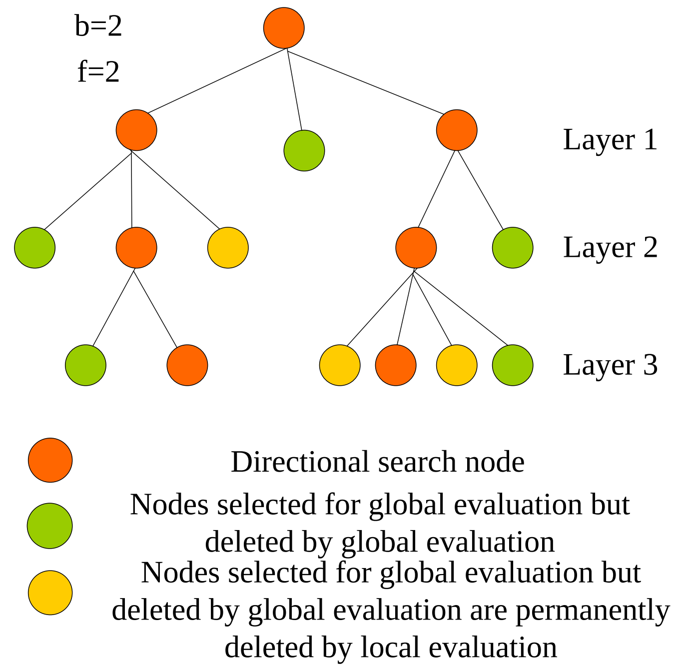

Figure 5. Representation of the filtered beam search tree

B. Search strategy

The heuristic method based on filtered directed search needs to solve the four search strategy definition problems when applied to the system processing dynamic scheduling problem.

The first: the search tree representation of the solution space uses the description method of figure. In each layer of the search tree, each node generated by the node branching strategy represents a scheduling decision for a process that includes the determination of the machine tool and the start time of the process on the machine. The connection between the two nodes is the decision to add a process from the upper node to the next node, and the added process is added to the local scheduling [22-24].

Second: the node branching strategy adopts the improved form of the earliest schedulable process priority policy NONDELAY, called the M-NONDELAY strategy. Suppose PS_t is the local schedule with l tracked operations, corresponding to PS_t, S_t is the collection of operations that can be scheduled in l layers.

T_{ij} is the time when the operation $O_{ij} \in S_t$ can start processing first; Mo_{ij} is the set of replaceable machine tools that can process O_{ij}; t_D is the delivery date; T_{ijk} is the time ($m_k \in Mo_{ij}$) that the machine tool can start processing O_{ij} at the earliest. The specific M-NONDELAY branching strategy is in formula:

a. Determine $T^* = \min o_{ij} \{T_{ij}\}$. Assume that the process O_{ij} ($O_{ij} \in S_t$) with $T_{ij} = T^*$ forms the set $\not{S}_t$;

b. Determine $t_{D^*} = \min o_{ij} \in \not{S}_t \{t_{D_i}\}$;

c. Pick the process with $t_{D_i} = t_{D^*}$. Assuming $Mt_{D^*} = Mo_{ij}$, for each machine belonging to Mt_{D^*}, the new node corresponding to local scheduling is generated, which contains the scheduling decision that the process is added to the local scheduling PS_t and the processing time is:

$$\max\left(T^*, \mathrm{T}_{ijk}\right), m_k \in Mt_{D^*} \tag{1}$$

d. $O_{ij} \in \not{S}_t$, and $t_{D_{ij}} = t_{D^*}$, but $Mo_{ij} \cap Mt_{D^*} \neq 1$. The new node corresponding to the local scheduling is generated, which contains the scheduling decision that the process O_{ij} is added to the local scheduling PS_t, and the processing time is: $\max\left(T^*, \mathrm{T}_{ijk}\right), m_k \in Mt_{D^*} \cap Mo_{ij}$

The third: the determination of b and f will affect search efficiency and performance. In general, the larger the b and fare, the better the optimization result is, but the longer the search time is; while the smaller b and f will increase the search speed, but the performance of the solution is poor. Therefore, in order to balance the contradiction between the two, in the calculation process $b \leq 10^9$, f will be set experimentally within a certain range.

Fourth: For the evaluation function, the algorithm uses the following three improved scheduling rules to construct the local and global evaluation functions. In the following description, $\left(O_{ij}, m_k\right), m_k \in Mo_{ij}$ indicates the decision that the process O_{ij} is assigned to the machine tool m_k.

a. M-MLB (Improved Machine Load Rules): Select the decision $\left(O_{ij}, m_k\right)$ with the highest job priority w_i. If more than one decision is available, select the machine with the lowest load;

b. M-SPT (improved small processing time rule): The decision to minimize the processing time of the process is selected. If there are multiple decisions, the priority is further based on the weight. If there are still multiple choices, select the machine with the lowest load;

c. M-EET (improved earliest end time rule): Choose the decision with the lowest end time. If there are multiple decisions, further priorities are based on weights. If there are multiple choices, select the machine with the lowest load.

Processing Target Segmentation Method based on Symmetric Difference Algorithm

At this time, if the processed object lacks internal texture, the difference between frames usually only gives the edge contour of the processed object. If the edge is occluded or subtracted to zero when it is differential, the hole in the object to be processed cannot be filled. And because there is no edge enveloping, the edge void is formed, which causes the segmentation edge to be missing and the processed object to be defective [25-30].

The processing target segmentation based on the symmetric difference algorithm uses the information obtained by the interframe difference algorithm and the background subtraction algorithm to segment the complete processed object. Since the complete edge contour information of the object cannot be obtained, the image information enhancement at the original cavity can be considered [31-32]. The content of the hole is filled by the background subtraction algorithm to prevent the occurrence of holes. This will increase the amount of information available during segmentation. The edge information provided by the symmetric difference and the information of the internal pixel values provided by the background subtraction algorithm participate in the segmentation of the moving object, and the segmentation quality is improved [33-35].

The algorithm flow is in formula:

A. The background model information of the precision box type processing target is obtained. First, the mean and mean square error of the processed image of the first n frames are obtained.

$$\mu_n(x,y)=\frac{1-n}{n}\mu_{n-1}(x,y)+\frac{1}{n}f(x,y)\left(O_{ij},m_k\right) \tag{2}$$

$$\sigma_n^2(x,y)=\frac{\sum_{i=1}^{n}\left(f(x,y)-\mu_n(x,y)\right)^2}{n-1} \tag{3}$$

where, $\mu_n(x,y)$ and $\sigma_n^2(x,y)$ respectively represent the mean and mean square error of the processing target in the first n frames at the (x,y) point.

Use the finite frame image $f(x,y)$ to create the background model for a precision box-like machining target:

$$B_0(x,y)=\frac{1}{m}\sum_{k=1}^{m}f_k(x,y) \tag{4}$$

where, $f_k(x,y)$ meet $\left|f_k(x,y)-\mu_n(x,y)\right|\le\beta_{\sigma_n}(x,y)$. β is a preset constant that can be determined based on the number of video frames being modeled. When the number of frames is large, it is set to 1. When the background model of the precision box type machining target is established in the first 20 frames, the value of m is 20. This method is better than the way of directly taking the average value of the previous m frame image.

B. The processing sequence of the precision box-like processing target is set to $f_{k-1}(x,y)$, $f_k(x,y)$ and $f_{k+1}(x,y)$ for three consecutive frames, and the absolute difference grayscale images of the original two adjacent frames are calculated.

$$d_{(k-1,k)}(x,y)=\left|f_k(x,y)-f_{k-1}(x,y)\right| \tag{5}$$

$$d_{(k,k+1)}(x,y)=\left|f_k(x,y)-f_{k-1}(x,y)\right| \tag{6}$$

D. Perform 3*3 median filtering on the above two absolute difference grayscale images, which will effectively eliminate random noise in the image. Because the pixels in the neighborhood have randomly changed pixels, after sorting, they are all ranked at the head or tail of the queue, and the new value of the center pixel is the pixel value taken from the middle of the queue. The image can obtain better visual effects after median filtering. The algorithm is faster and retains the edge information of the original image.

D. Binarize the image by using appropriate threshold values for the two absolute difference grayscale images of the filtered precision box-like processing target. $b_{(k-1,\mathrm{k})}(x,y)$ is the binarization of the difference between the first two frames.

$$b_{(k-1,\mathrm{k})}(x,y)=\begin{cases}1, & b_{(k-1.k)}(x,y)>T\\ 0 & b_{(k-1,k)}(x,y)\le T\end{cases} \tag{7}$$

The threshold is determined using the system noise measurement method, that is, after the system device determines, the difference is made to the completely still video picture taken by the video system. The difference image distribution is obtained by the histogram, which is mainly determined by the noise of devices such as cameras.

E. Image and operation of precision box processing targets. When the certain threshold is binarized, two absolute difference binary images $b_{(k-1,\mathrm{k})}(x,y)$ and $b_{(\mathrm{k},\mathrm{k}+1)}(x,y)$ are obtained. At each pixel location, two images are manipulated. If the forward frame difference and the posterior frame difference are both 1 at the pixel point (x,y), the value after the intersection is still 1, otherwise it is 0. The obtained image $B_k(x,y)$ is the preliminary result of the separation of the processing target from the background in the k-frame image.

F. Morphological operation of precision box processing targets. When the processing target in the k-th frame source image separates the preliminary result from the background, the small residual noise of the background can be eliminated by the morphological corrosion, expansion, etc., and the edge of the processed object is smoothed.

G. Connect operator operation. The connected operator is used to mark the connected area, and by calculating the area of each marked moving area, the area whose area is smaller than a certain threshold is deleted, that is, the small area noise is removed. The setting of the area threshold is related to the specific application area and the object to be detected.

H. Each processing target of the connected label itself is a circumscribed rectangle. The circumscribed rectangle is an exception area for the background update, that is, because the pixels inside the rectangle are highly likely to belong to a moving object, they are excluded from the background update.

I. Update of the background model. The area other than each circumscribed rectangle updates the background in real time with the current frame pixel value. The motion area within the circumscribed rectangle as a possible machining target does not update the background. As the moving object moves, all backgrounds are updated. When no processing target is detected in the scene, all pixels of the current frame are replaced by all pixels of the current frame to reconstruct a new background. If the moving object is detected, after connecting the operator operation, the pixels other than the circumscribed rectangle are updated with the background by obtaining the position coordinates of the circumscribed rectangle of the marked processing target. The background pixels corresponding to the pixel locations within all circumscribed rectangles are not updated [36-41].

J. Using the background subtraction method to obtain the precision object-type processing target information and the inter-frame difference combination.

K. Perform the second morphological operation on the results.

L. Extract the contour of the machining target, and the algorithm ends.

RESULTS

System Effectiveness

In order to verify the effectiveness of the system, the system is applied to a precision cabinet manufacturing plant. The original image of the precision cabinet parts is described in Fig. 6.

Figure 6. Original image of precision box parts

The diagram of a precision box part that is divided during processing using the system of the present invention is depicted in Fig. 7.

Figure 7. Precision box part drawings after system processing and segmentation in this

Analysis of Fig. 6 and Fig. 7 shows that the system can better segment the details of the precision box parts, and the finished product has high integrity.

System Performance

In order to further analyze the effectiveness and practicability of the system, the experiment was performed using Visual C++ 6.0 on Intel Pentium IV, 512 MB memory computer and Windows 2000 platform. The system, flexible energy dispatching system and flexible body adaptive high-precision manufacturing system are used for comparison experiments to detect the comparison of different systems with job batches, workpiece batch size and workload. The comparison performance is the number of experience IDs and the maximum completion time for different search depths. The experimental results are shown in Table 1, Table 2 and Table 3.

Table 1. Performance comparison of different systems with batch sizes of jobs (5, 5, 2, 2)

Depth	number of markings/makespan			CPU time (s)		
	Flexible energy scheduling system	Adaptive high precision manufacturing system for flexible body	Paper system	Flexible energy scheduling system	Adaptive high precision manufacturing system for flexible body	Paper system
20	1.000/1.000	2.302/1.068	0.913/0.993	3	5	1
40	1.952/0.909	6.480/0.966	1.145/0.817	11	29	5
50	5.028/0.795	8.597/0.898	3.827/0.781	32	41	13
60	6.129/0.727	11.190/0.841	4.793/0.711	46	67	22
80	6.802/0.705	13.339/0.727	4.924/0.693	55	90	31

Table 2. Performance comparison of different systems with workpiece batch sizes (8, 8, 4, 4)

Depth	Number of markings/makespan			CPU time (s)		
	Flexible energy scheduling system	Adaptive high precision manufacturing system for flexible body	Paper system	Flexible energy scheduling system	Adaptive high precision manufacturing system for flexible body	Paper system
20	1.000/1.000	6.646/1.031	0.943/0.984	4	60	3
40	2.718/0.859	8.947/0.945	2.091/0.807	15	73	8
50	4.911/0.742	13.161/0.859	3.994/0.711	37	89	16
60	7.769/0.687	15.075/0.779	6.793/0.644	52	115	34
80	13.752/0.638	15.783/0.663	8.372/0.626	63	134	47

Table 3. Performance comparison of different systems with job lot sizes (10, 10, 6, 6)

Depth	Number of markings/makespan			CPU time (s)		
	Flexible Energy Scheduling System	Adaptive High Precision Manufacturing System for Flexible Body	Paper system	Flexible Energy Scheduling System	Adaptive High Precision Manufacturing System for Flexible Body	Paper system
20	1.000/1.000	5.009/0.986	0.981/0.971	15	170	7
40	1.846/0.866	9.841/0.947	1.475/0.823	44	610	29
50	6.774/0.775	13.239/0.861	4.058/0.757	526	994	152
60	9.065/0.718	16.073/0.809	7.849/0.682	1047	1351	178
80	15.052/0.708	17.382/0.732	7.849/0.682	1213	1579	178

From the data of the three tables, it can be seen that the performance of the three systems is compared under different batch sizes. The number of experience identifications and maximum completion time of the system in this paper are less than the other two systems, which indicates that the system can effectively reduce the number of identifications and maximum completion time experienced in the processing of precision cabinet parts.

Figs. 8-10 are the smoothing indices for the different search depths for the three systems at different batch sizes.

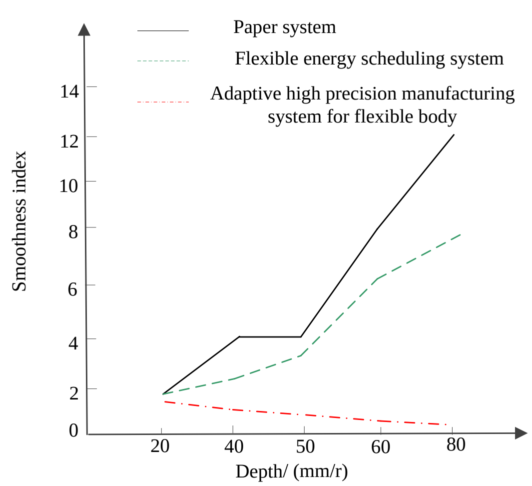

Figure 8. Smooth index of batch size of workpiece (5, 5, 2, 2)

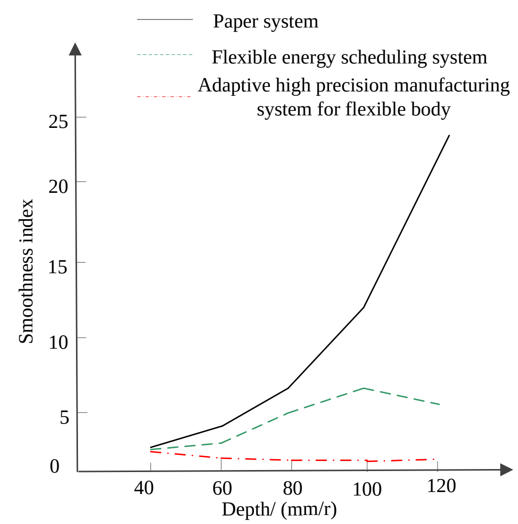

Figure 9. Smooth index of batch size of workpiece (8, 8, 4, 4)

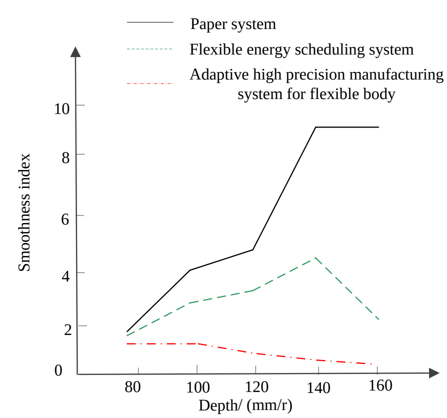

Figure 10. Smooth index of batch size of workpiece (10, 10, 6, 6)

It can be seen from the above picture that when the workpiece batch is (5, 5, 2, 2), The smoothness index of the system increases gradually with the increase of the search depth, and the maximum value is 13. The flexible energy scheduling system has a smoothing index maximum of 8. The flexible body adaptive high precision manufacturing system has a smoothness index maximum of 1.5. When the workpiece batch is (8, 8, 4, 4), the smoothness indices of the three systems are 25, 8 and 3, respectively. When the workpiece batch is (10, 10, 6, 6), the smoothness indices of the three systems are 9, 4.5 and 1.8, respectively. It can be seen that with the increase of the search depth, the balance ability of the system increases gradually, and the system scheduling ability is better.

The time-consuming conditions of the three systems in the above experiments are counted and compared. The time-consuming results of the three systems are described in Fig. 11, Fig. 12 and Fig. 13, respectively.

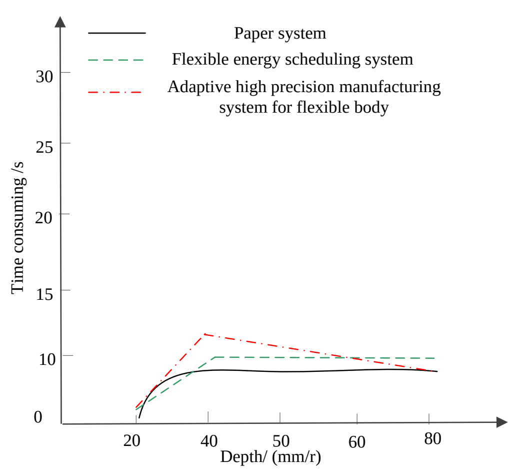

Figure 11. Time-consuming situation of three systems with batch size of workpieces (5, 5, 2, 2)

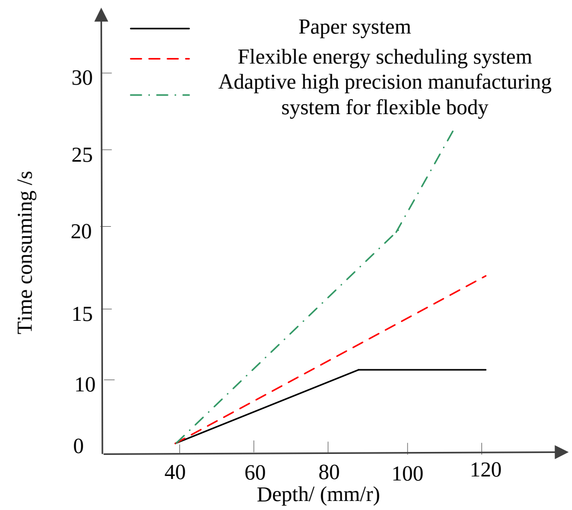

Figure 12. Time-consuming situation of three systems when the batch size of workpiece is (8, 8, 4, 4)

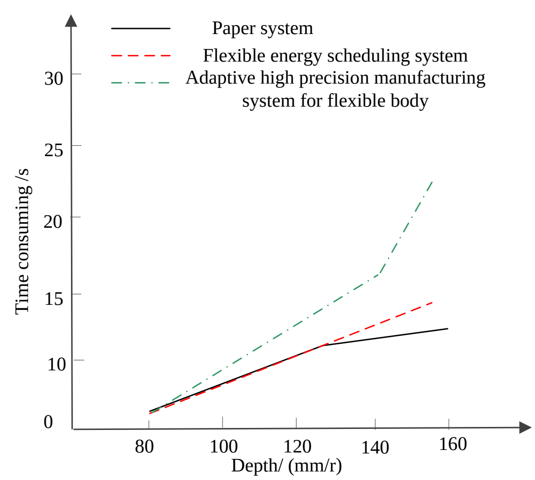

Figure 13. Time-consuming situation of three systems when the batch of work pieces is (10, 10, 6, 6)

It can be seen from the picture information that when the workpiece batch is (5, 5, 2, 2), the maximum time consumption of the system is 8 s, and the maximum time of the flexible energy dispatching system is 10 s. The maximum time of the flexible body adaptive high-precision manufacturing system is 13 s. When the workpiece batch is (8, 8, 4, 4), the maximum times of the three systems are 10 s, 27 s and 18 s; when the workpiece batch is (10, 10, 6, 6), the maximum times of the three systems are 12 s, 24 s and 15 s. It can be seen from this that with the increase of the search depth, the processing time of the workpiece is the shortest and the processing efficiency of the system is fast.

DISCUSSION

In view of the above analysis, the development trend of the precision box-type flexible manufacturing system is summarized as follows:

A. The precision box-like flexible manufacturing system entered the practical stage in the late 1980s, and the technology is relatively mature, but it will continue to develop. Because it has obvious economic benefits in solving multi-variety, small- and medium-sized production than traditional processing technology, it has been given enough attention as international competition has intensified. The system was originally used for machining non-rotating parts, and is usually used for drilling, boring, milling and tapping. With the development of technology, it can not only complete the processing of other non-rotating body parts, but also complete the turning, grinding, broaching and gear processing of the rotating parts. From the industry perspective, the system can not only complete machining, but also complete sheet metal processing, forging, welding, assembly, casting and special processing such as laser and electric spark, as well as painting, heat treatment, injection molding and rubber molding. From the perspective of products manufactured by the entire manufacturing industry, it is no longer limited to automobiles, lathes, airplanes, tanks, artillery, ships, but also for the production of computers, semiconductors, wood products, clothing, food, pharmaceuticals and chemicals. From the production batch point of view, the system has been developed from small and medium batch applications to single-piece and high-volume production. Studies have shown that any process that can be controlled by numerical control and computer can be completed by the manufacturing system.

B. The system configuration of the precision box-like flexible manufacturing is progressing toward the flexible manufacturing unit FMC. Like the precision box-like flexible manufacturing system, the flexible manufacturing unit FMC can meet the flexible manufacturing needs of many varieties and small batches, but it has its own unique advantages. First of all, it is small in scale, low in investment, low in technology comprehensiveness and complexity, relatively simple in planning, low in risk, easy to design, demonstration, expand, operation and implement. It is the important ladder for the development of advanced large-scale FMS. In this way, it can reduce the investment of one investment, make the enterprise easy to bear, reduce the risk and be easy to succeed. Once successful, you can get benefits, provide funding for the next expansion, and also develop talents and experience to make the implementation of precision cabinet-based flexible manufacturing systems more secure. Second, the current FMC is no longer synonymous with a flexible manufacturing system for primary precision cabinets. It not only has the processing, manufacturing, storage, control, coordination functions of the manufacturing system, but also functions such as monitoring, communication, simulation, production scheduling management and artificial intelligence. In the specific type of processing, it helps to achieve greater flexibility, increase productivity, increase production, and improve product quality.

CONCLUSIONS

The precision box-like flexible manufacturing system based on symmetric differential algorithm is designed in this paper. The hardware consists of information integration management module, logistics management module and processing module. The logistics control management module is the control interface of the other two modules. It formulates the operation plan of the system according to the information integration management module, and transforms the plan into the control information executable by the processing module. According to this, the machining task is automatically completed in the machining module. In order to effectively solve the dynamic scheduling problem of the system, the dynamic scheduling optimization strategy based on filtered directed search is used to improve the efficiency of system processing, and the processing target segmentation method based on symmetric differential algorithm is used to accurately extract the contour information of the target. This can greatly improve the quality of the processed object. The experimental results show that the system can segment the details of the precision box parts and produce a relatively complete product. As the depth of search increases, its balance ability gradually increases, the system scheduling ability is better, and the time is the shortest. This design has the use value.

ACKNOWLEDGEMENT

This research is supported by Jilin science and technology development plan project (No. 201105018).

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