JJMIE

Volume 14, Number 1, March. 2020
ISSN 1995-6665
Pages 53 - 60

Jordan Journal of Mechanical and Industrial Engineering

An Adaptive Scheduling Method for Resources in Used Automobile Parts Recycling

Pengfei Ning

Department of Logistics, Guangzhou College of Technology and Business, Guangzhou, 510850, China

Received OCT 16 2019 *Accepted JAN10 2020*

Abstract

When using the current method to schedule the resources in parts recycling, the resource scheduling delay is relatively long, which reduces the efficiency of parts resource scheduling, resulting in a low resource utilization rate. This paper proposes an adaptive scheduling method for parts recycling resources based on improved reverse particle swarm optimization. The current situation of waste vehicle recycling resource scheduling is analyzed, and the mathematical model of component recycling resource scheduling is constructed to consider time and cost. The reverse particle group is used to dispatch component recovery resources, and the inertia weight parameters are adjusted. The adaptation mechanism regards the degree of change of the particle function as the update factor of the inertia weight, avoiding the value according to the number of iterations; introducing the inverse learning operator, strengthening the ability of resource scheduling global search, and completing the recycling of used automobile parts and components Adaptive scheduling. The experimental results show that the proposed method has the highest recovery resource utilization rate, and the task time is about 200-400s, and the energy consumption is small. The proposed method can effectively schedule resources and improve the utilization of resources.

Keywords: used automobiles; parts recycling; resource scheduling; reverse particle swarm optimization.

1. Introduction

In the process of rapid social development, automobile is the symbol of material civilization, which has brought changes to human life. But at the same time, with the rapid development of the automobile industry, the abandonment of used automobile machine parts has caused great negative pressure on the environment[1]. In order to alleviate the shortage and used of resources and reduce the harm to the environment caused by used automobile parts, it is of great significance to reuse the parts of used automobiles to the maximum extent.

According to the latest statistics released by the China Automobile Industry Association on January 10, 2018, China's automobile production and sales exceeded 28 million vehicles in 2017, up 36.48% and 38.57% respectively from the same period last year, reaching a new high in production and sales and setting a new global historical record. At the same time, according to the analysis of professional experts in the world's first automobile market, China's automobile industry is still showing a good development trend in 2018, with an expected growth rate of between 20% and 25%. Data from the Traffic Administration Bureau of the Ministry of Public Security show that at the end of 2017, China's car ownership has reached 96.191.31 million vehicles, so according to the theoretical used rate of 6%, more than 577 vehicles are usedped each year. By 2020, China's car ownership is expected to exceed 150 million vehicles, and the used will exceed 9 million vehicles. Some people say that after becoming the world's largest parking lot, China is becoming the world's largest garbage dump.

In the recycling of used automobile parts and components, the amount of recycled resources is relatively large. Therefore, it is a hot issue in this field to allocate the recycled resources of automobile parts reasonably, schedule the tasks submitted, reduce the cost of execution and shorten the processing time [2].

In-depth research on recycling resource scheduling of used automobile parts is the key content of the research in the field of used automobile resources, and its application is very extensive[3]. In the use of used automobile parts recycling, spare parts resources are similar to water resources. After providing to users for use, users only need to use their own resources. As a result, the supplier of spare parts resources can manage the resources more conveniently and provide them to the users, while the users can use the spare parts resources at a lower price[4]. However, there is a problem of poor resource utilization efficiency when the spare parts resources are dispatched at present. Therefore, the scheduling of recycling resources of used automobile parts is studied [5].

In reference[6], resource scheduling model for automobile parts based on parallel resources and serial tasks is proposed using ant colony algorithma. The

* Corresponding author e-mail: npf561@163.com.

dynamic tasks submitted by users are divided into constrained sub-tasks, which are placed in the resource scheduling queue according to the running order. Aiming at the tasks in the same resource scheduling queue, the ant colony algorithm based on the shortest resource scheduling task is used to schedule the spare parts resources. Under the premise of fair scheduling, the delay time of resource tasks is shortened to maximize the satisfaction of users. The experimental results show that compared with other parts resource scheduling algorithms, this algorithm is fairer in scheduling, but because of the long delay of scheduling tasks, it reduces the utilization of parts resources.Reference[7]proposes a resource scheduling method for automobile parts recycling based on minimum cost with genetic algorithm. The problem of resource demand and supply of spare parts task is transformed into the problem of solving minimum cost. Choosing fairness, placement optimization and priority as entry points, from the mapping of automobile spare parts resources to graphs, the problem of construction is discussed. By changing the structure of the graph, the structure of the graph can be adjusted. Aiming at the high time complexity of resource scheduling, the incremental optimization of resource scheduling is realized. Finally, experiments on fairness, placement constraints and priority scheduling are carried out to verify the flexibility of the method in supporting multiple scheduling objectives. The simulation results show that the proposed method can effectively schedule spare parts resources, but the method has the problem of low resource utilization.

2. Material And Methods

2.1. Duality of Used Automobile Resources

The duality of used automobile resources is environmental pollution and resource. Used automobiles contain many kinds of different materials, such as metal materials, non-metallic materials and a small amount of organic materials. Some of the components will also cause harm to the environment[8].

1. Metal materials, include steel plate, cast iron, aluminum and copper and their alloys, zinc, lead and so on. In order to prevent corrosion, the surface of steel plate is usually galvanized, tinned and aluminized, etc. Others, such as copper, are also used in automobile manufacturing. If used automobile cannot be recycled in time, some heavy metals will remain in the environment for a long time, which not only destroys the ecological environment, but also will enter the human body along with the food chain, causing health threats[9].
2. Non-metallic materials, include plastics, glass, rubber, coatings, leather, fibers and so on. Among them, the "black pollution" caused by used tires is a serious problem. The long-term open-air stacking of used tires not only occupies land, but also easily breeds mosquitoes, spreads diseases and causes fires. On September 22, 1999, Stanislaus in Northern California, USA, 7 million used tires are spontaneously ignited, causing air pollution. Coatings are mainly used for anti-corrosion and beautifying the appearance of the car body, although the proportion is small, if improperly handled, it will pollute the environment. Air conditioning refrigerant, antifreeze and brake oil in used cars are all serious pollution sources. Once they are leaked, they will cause environmental pollution and destroy the ozone layer in the atmosphere.
3. A small amount of organic matter in automobile parts not only pollutes the environment, but also seriously affects human health, as shown in Table 1. Some chemicals such as asbestos and ammonia nitrite contained in rubber can cause cancer.

Table 1. Chemicals in Automobiles Affecting Human Health

Chemical varieties	Site of use	Harmfulness
Asbestos	Brake pad and gasket	Carcinogenic
Ozone destroyers (CFC, trichloroethane, carbon tetrachloride)	Air conditioning, foaming agent, detergent	Ultraviolet irradiation
Polybutylphenol chloride (PCB)	Condenser	Harmful health
Polypropofol chloride (PCT)	Lubricating oil and insulating oil	Harmful health
Polychlorinated naphthalenes	Heat transfer agent	Harmful health
Cadmium (Cd)	Electric contact, anti-corrosion, electroplating	Harmful health
Mercury	Sensors and meters	Harmful health
Tribromopropionate and polybutylbromide	Combustion improver	Harmful health
2- naphthalene ammonia	Rubber antioxidant	Carcinogenic
4-amino-diphenyl	Cutting oil	Carcinogenic
Aromatic nitrite	Rubber	Carcinogenesis (nitrite ammonia)
Aliphatic grade two ammonia	Rubber	Carcinogenesis (nitrite ammonia)
Aliphatic secondary amines	Rubber	Carcinogenesis (nitrite ammonia)
Nitrite	Rubber	Carcinogenesis (nitrite ammonia)

From the above analysis, if not properly handled, used automobiles will not only harm the environment, but also cause a lot of used of resources. If, after the recycling and discarding of automobiles, reasonable disassembly and processing can make the second full use of its constituent materials, of which more than 60% of the steel can be recycled 100%; nonferrous metals, which account for 3%-4.7%, such as aluminum, magnesium and copper, can be broken and sorted, and a large part of them can also be recovered. Recycling, utilization and disposal of used automobiles have attracted great attention in developed countries. The recycling and reuse of used automobiles has become an important factor to make up for the shortage of natural resources. China's government has taken "taking automobiles as the object, providing a set of recyclable and disassemble technologies, and combining them with enterprises, establishing demonstration sites" as one of the objectives and main research contents of the 11th Five-Year Plan. Therefore, developing advanced and efficient related technology research has become an important part of promoting the healthy development of automobile recycling and reuse industry [10].

2.2. Significance and Function of Recycling and Utilization of Used Automobiles

Used automobiles are resource-intensive and high value-added products. In developed countries with market economy, great attention has been paid to the effective recycling of useful materials, such as used iron and steel, used non-ferrous metals and used plastics from used automobiles, moreover, the recycling management and recycling technology have been constantly improved. The significance and function of recycling used automobiles are mainly manifested in the following aspects:

1. The potential of resources is enormous. Some parts of used automobiles can be reused or remanufactured, such as engines, bumpers, etc. After testing and repairing, they can be reused. Not only can the performance meet the use requirements, but also the cost is relatively low. This fully demonstrates that recycling used automobiles can reduce the exploitation of primary resources, alleviate the pressure of resource scarcity per capita in China, and meet the needs of sustainable economic development [11-13].
2. The effect of environmental protection is significant. The recycling of used automobiles can reduce the environmental pollution caused by mining and refining of original mineral deposits and manufacturing of new products, and can greatly save energy and reduce greenhouse gas emissions.
3. The stress of employment is alleviated. The implementation of the recycling of used automobiles will bring about a number of new industries, which can partly relieve the employment pressure [14].
4. It can provide cheaper products. Through the development of remanufacturing as the main resource, we can fully extract the added value contained in the products and provide the products with good quality and low price. The remanufacturing process restores the performance of parts and components according to the standards of new products through comprehensive disassembly and identification of products, so that the quality of remanufactured products can be equal to or even higher than that of new products.

2.3. Adaptive scheduling of resources in used automobile parts recycling

The resource recycling of used automobile parts is based on the used automobile parts as the object, through modern technology and process, under the standard market operation, to maximize the development and utilization of materials, energy and economic value-added wealth contained therein and make it a resource with high grade and usable, can achieve the purposes of energy saving, material saving and environmental protection [15].

The establishment of recycling model of used automobile parts must be supported by perfect system and relevant laws and regulations. The developed countries in Europe and the United States, especially Germany and the United States, have formulated a relatively perfect recycling system for the reuse of abandoned vehicles and used products, as shown in Figure 1. The end-users of automobiles submit applications for used vehicles to the designated recycling points. After the recycling points are transferred to the designated used vehicle recycling units and disintegrated, the dismantled products are classified and sent to the used vehicle recycling plants and treatment plants in accordance with the recycling laws and regulations promulgated by the government departments, and then the relevant incentives and subsidies are used to promote the used vehicles recycling proceeds [16].

This system, through market mechanism, combines users, government departments, recyclers and recycling funds, jointly carries out the work of resource recycling and reduction, and encourages the participation of the whole people by using the feedback mode. By drawing lessons from foreign experience in used automobiles recycling and combining with the current situation of China, this paper summarizes the process chart of used automobile parts recycling by studying the dismantling and recycling process of used automobiles, as shown in Figure 2.

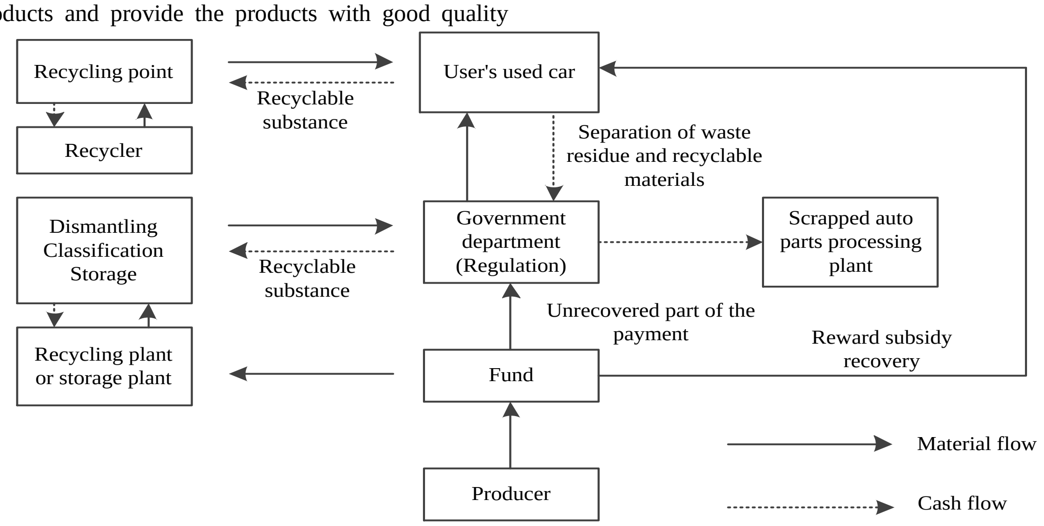


Figure 1. Automobile parts recycling system

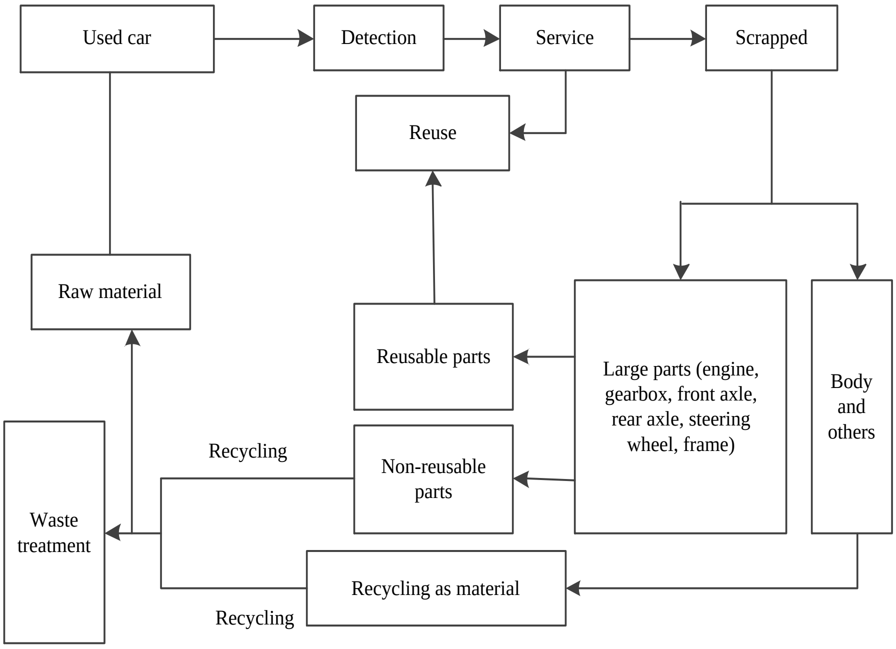


Figure 2. The process chart of automobile parts recycling

In the process of automobile parts recycling, the resource flow of used automobile parts is mainly reflected in the following four aspects [17-18]:

1. Reusable spare parts, used automobile parts cannot achieve equal life design, when the automobile is scrapped, there will always be a part of spare parts with good performance, which should be used directly after passing the test. It can be used as spare parts, and can also enter the product remanufacturing production line to produce remanufactured products.
2. Remanufacturable parts and components, it can absorb various new technologies and processes including advanced surface engineering technology, and implement remanufacturing or upgrading to produce remanufactured products with the same or higher performance than the original products;
3. Recyclable parts, which cannot be repaired or economically inexpensive at present, are recycled as parts for material recycling;
4. Waste disposal, some of which cannot recover their resources through reusing, remanufacturing and recycling procedures at present, can only be safely disposed of through landfills and other measures.

The recycling of used automobiles should realize the recycling of resources as much as possible. Used automobiles are recycled through the multi-level recycling ways of raw materials utilization layer, parts repair utilization layer and direct utilization layer to return to the manufacturing plant in the recycling system. The renewable and available resources are returned to the life cycle of automobiles or into various stages of the life cycle of other products, thus avoiding the waste of resources and reducing the pollution of the environment.

Based on the analysis of the present situation of the resource recycling scheduling for used automobile parts, this paper constructs a mathematical model for the resource recycling scheduling of parts, and considers the time and cost of the resource recycling scheduling of parts. Inverse particle swarm optimization (RPSO) is used to schedule the recovery resources of parts and components and to adjust the inertia weight parameters. The degree of change of particle function is regarded as the update factor of inertia weight by adaptive mechanism, which avoids taking the value according to the number of iterations, so that the particle will not fall into the local optimum. By introducing the operator of reverse learning, the ability of global search for resource scheduling is strengthened, and the adaptive scheduling for recycling resources of used automobile parts is completed.

2.3.1. Establishment of Mathematical Model for Resource Scheduling of Automobile Parts

Before establishing the mathematical model for recycling resource scheduling of used automobile parts, the hypothesis is made:

1. Virtual machine performance can fulfill any task requirement;
2. All resources and tasks can be allocated;
3. Only one resource is allocated to a task;
4. Random allocation can be guaranteed.

There are m resources and n users in the recycling resources of used automobile parts. The mathematical model for the recycling resources scheduling of used automobile parts is described as follows:

$$M = \{U, V, F, \theta\} \tag{1}$$

In formula (1), U denotes the set of users, V denotes the set of parts recycling resources, F denotes the objective function, and θ denotes the algorithm for solving.

The specific characteristics of the mathematical model for the recycling resources scheduling of automobile parts are as follows:

1. The i th part resource (v_i) is divided according to its location and use, that is $v_i = \{\lambda_i, \mu_i, \varphi_i\}$. Thus, the part recycling resource is expressed as $V = \{v_1, v_2, \cdots, v_m\}$.

2. For a user has n tasks, different tasks are independent of each other. Therefore, all resource task sets are described as $T=\{t_1,t_2,\cdots,t_n\}$, task execution time $S_{m\times n}=\{x_{ij}\}$, where x_{ij} is the time of task execution on component resource j [19].
3. The scheduling matrix E of spare parts resource is expressed as: $E_n=(e_i)$ is that spare parts recycling resource e_i performs task i, and the matrix used for resource utilization is $X_{m\times n}=\{X_{je_i}\}$, where X_{je_i} is that spare parts recycling resource e_i is used by task j.

In combination with the above, the time to complete the task of recovering parts and components resources v_i is as follows:

$$T_j=\max\{x_{ij}\}, i=1,2,\cdots,n, j=1,2,\cdots,m \quad (2)$$

For m used automobile parts recycling resources, the total time to complete the task is expressed as:

$$makespan=\sum_{j=1}^{m}\max\{x_{ij}\cdot x_{je_i}\} \quad (3)$$

In the process of scheduling spare parts recycling resources, the completion time of scheduling is an evaluation criterion in resource scheduling schemes, and the cost of scheduling should also be considered. Assuming that the cost per unit time of parts recycling p_j is expressed as:

$$p_j=p_{i1}\times\alpha_i+p_{i2}\times\beta_i+p_{i3}\times\gamma_i \quad (4)$$

In formula (4), p_{ij} denotes the cost of recycling resources from components. α_i 、 β_i 、 γ_i represent the weight of the corresponding part at the time of recovery in the total build.

For a task, the cost P_i of parts recycling resources v_j is expressed as:

$$P_i=(p_{ij}\times\alpha_i+p_{i2}\times\beta_i+p_{i3}\times\gamma_i)\times\sum_{j=1}^{m}\max\{x_{ij}\cdot x_{je_i}\} \quad (5)$$

For all tasks, the total cost P of parts recycling resources is expressed as:

$$P=\sum_{j=1}^{m}p_j\times\max\{x_{ij}\cdot x_{je_i}\} \quad (6)$$

Thus, the total cost of scheduling can be minimized by using the spare parts recycling resource scheduling and objective optimization function [20].

2.3.2 Parts Recycling Resource Scheduling based on Improved Inverse Particle Swarm Optimization

It is assumed that the particle motion space is N-dimensional, the number of population is z, and the number of iterations is t. In the search space, the position of the i th particle is $x_i=(x_{i1},x_{i2},\cdots,x_{iN})$, $i=1,2,\cdots,m$. The particle fitness is obtained by introducing x_i into the particle the parameters. The local optimum position of the i th particle in the t th time of iteration search is p1 $p_i(t)=(p_{i1},p_{i2},\cdots,p_{iN})$, and the optimum position of the particle swarm search for parts recycling resources is $p_g(t)=(p_{g1},p_{g2},\cdots,p_{gN})$, g is the particle subscript for the global optimum position.

Considering the completion time of spare parts recycling resource scheduling in Section 3.1 above, all completion time is defined as fitness function, which is expressed as:

$$T(X)=\max_{j=1}^{m}\sum_{i=1}^{n}x_{ij}time_{ij} \quad (7)$$

In the upper formula, $time_{ij}$ indicates the completion time of resource scheduling, x_{ij} indicates the task execution time on the build resource.

Aiming at the characteristics of resource scheduling for used automobile parts recycling, the coding method of task-to-computing node vector is adopted. a tasks are allocated to b computing resource nodes. Particle encoding method is $R=\{r_1,r_2,\cdots,r_m\}$, where r_i is an integer, and $x_i\in[0,n-1]$ is the label of computing resource nodes. For example, $R=(2,0,3,1,4)$ means to assign five tasks to five computing resource nodes labeled 0, 1, 2, 3, 4. Among them, the first task is assigned to No. 2, the second task is assigned to No. 1, and so on.

The selection of particle inertia weight ζ has an important influence on the search ability and convergence of resource scheduling algorithm. If the fitness function of the current position and the function value of the last iteration position of a certain component resource particle are relatively small, it means that the scope of particle search is relatively small, and the search scope needs to be increased, so that the parts recycling resource particle can jump out of the local optimal interval, and reach the divergent state. When the difference between the fitness function of the current position and the function value of the last iteration position is large, the inertia weight is reduced, which makes the recovery of resource particles converge. When the resource particle falls into local optimum, the range of particle motion needs to be increased to realize the mutation operation of particle motion for parts recycling [21-23].

Based on the above considerations, a method for selecting the inertia weight ζ of adaptive mechanism is proposed.

$$\zeta(t+1)=1-0.5f(t) \quad (8)$$

The $f(t)$ in formula (8) is determined by formula (9):

$$f(t)=\frac{F(x_g(t))}{F(x_g(t-1))} \quad (9)$$

In formula (9), $F(x_g(t))$ represents the function value of the global optimum fitness of current parts recycling resource particles. When the value of particle update factor $f(t)$ is between $[0,1]$, when the value is 0, it means that the distance from the optimal point is far, the value of ζ needs to be reduced, and when the value is 1, it means that the distance from the optimal point is close, and the value of ζ needs to be increased.

In order to expand the scope of particle search for parts recycling resources, an inverse learning operator is introduced to the particles. Based on the particle labeling method, the inverse learning operator is defined as $y_i = d - x_i$. d denotes the total number of recycled resource nodes, and the position of the particle motion obtained by reverse learning is $Y = (y_1, y_2, \cdots, y_m)$. When the recycled resource particles fall into the local optimal solution, the reverse learning mechanism is used to realize the mutation operation of the particles, which can only adapt to the recycled resources scheduling of used automobile parts.

3. Results

In order to prove the effectiveness of the proposed resource adaptive scheduling method, practical experiments are carried out.

Setting of the experimental environment: a resource scheduling experiment is carried out under the Matlab simulation environment. The operating system is Windows 10, the processor is Core i4, and the memory is 4 G. By using the method, the particle swarm is used for reverse application, and the search range of the recovered resource particles is enlarged.The main parameters of PSO are represented in Table 2.

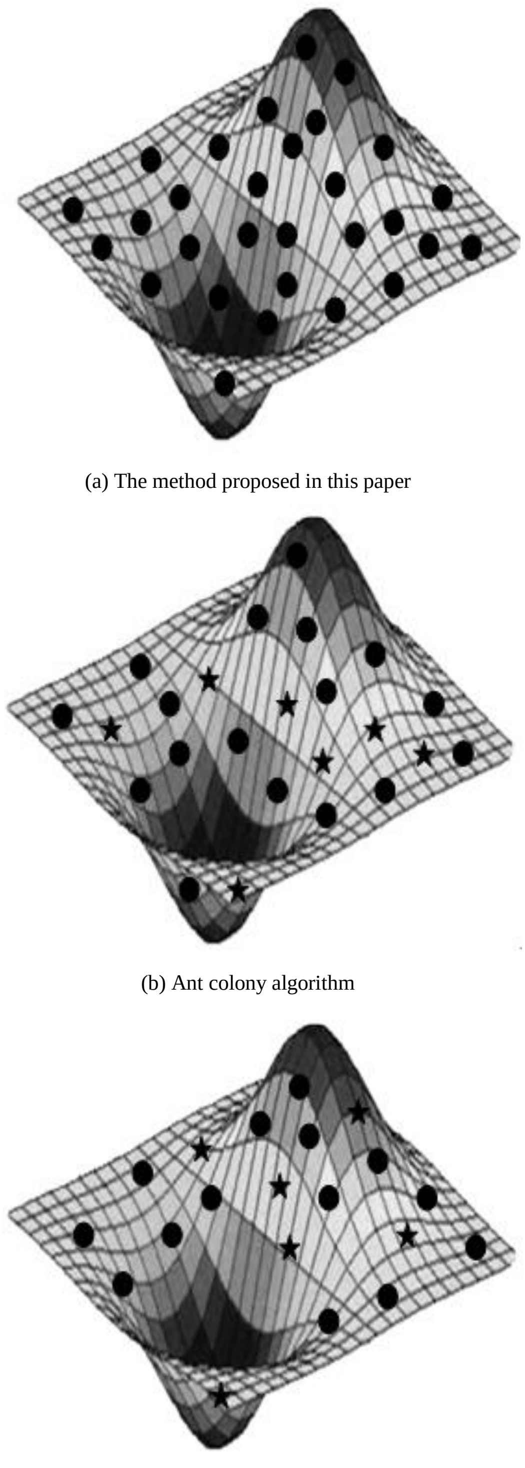
Table 2. Experimental parameters of particle swarm optimization

Parameters	Numerical value
Population size /m	200
Number of task resources/m	22
Number of computing resources/n	6
Learning factor 1	1
Learning factor 2	1
Size of external files	110

3.1. Testing of Utilization Rate of Recycling Resource

Figure 3 shows the comparison of the proposed method with ant colony algorithm and genetic algorithm. The following figure shows the resource utilization outside the plan in the Pentagon's three-dimensional coordinates the circle represents the recycled resources of the parts used, and the more the circles are, the higher the utilization rate of the recycled resources of the parts is.

It can be seen from the analysis of Figure 3 that the number of circles in the result graph of this method is the largest, which proves that the utilization rate of parts recycling resources based on the improved reverse particle group component recycling resource method is higher than that of ant colony algorithm. The resource utilization of the genetic algorithm can effectively utilize the used resources.



(a) The method proposed in this paper

(b) Ant colony algorithm

(c) Genetic algorithm

Figure 3. Comparisons of resource utilization rate of spare parts recycling using different algorithms

3.2. Time-consuming Test for Completing Tasks

In the same environment, the completion time of resource scheduling tasks by using the proposed method is compared with that of ant colony algorithm and genetic algorithm, and the results are shown in Figure 4.

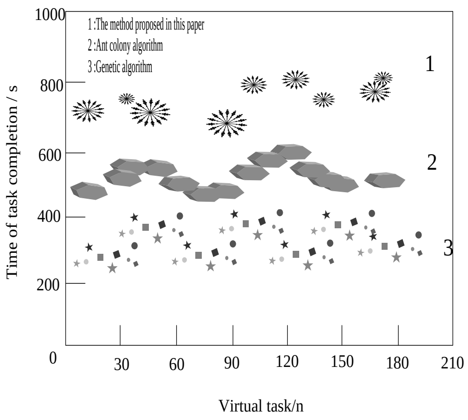


Figure 4. Comparisons of Completion Time of Resource Scheduling Tasks with Different Algorithms

The analysis of Figure 4 shows that the task completion time of the proposed method is significantly less than that of the ant colony algorithm and genetic algorithm. With the increase of resource tasks, the task completion time of the proposed method does not fluctuate greatly and is relatively stable. However, the task completion time of the existing ant colony algorithm and genetic algorithm fluctuates greatly with the increase of resource tasks.

The above experiments show that the method proposed in this paper can effectively reduce the completion time of recycling tasks and improve the scheduling efficiency of spare parts recycling resource .3.3 Energy Consumption Test for Resource

The energy consumption is used as an index for judging the scheduling effect. The energy consumption of the proposed method is compared with that of ant colony algorithm and genetic algorithm in resource scheduling. The energy consumption calculation formula is as formula (6):

The results are shown in Figure 5.

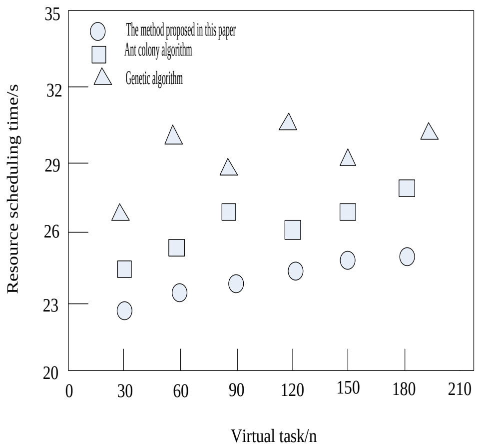


Figure 5. Comparison of Energy Consumption in Resource Scheduling with Different Algorithms

Analysis of Figure 5 shows that compared with ant colony algorithm and genetic algorithm, the energy consumption of the proposed algorithm is lower than that of the other two algorithms. With the increase of resource tasks, the energy consumption of the proposed algorithm is stable, while the energy consumption of the other two algorithms fluctuates greatly. The above experiments show that the algorithm proposed in this paper can effectively improve the resource utilization rate of spare parts recycling .

4. Discussion

In the inspection of resource utilization, the resource utilization rate of parts recycling based on improved reverse particle swarm optimization is significantly higher than that of ant colony algorithm and genetic algorithm. This is mainly because this method adjusts the inertia weight parameters on the basis of the original particle swarm optimization. The introduction of inverse learning operator can improve the global search ability of particle swarm optimization, and promote parts recycling resource nodes to deal with more resource scheduling tasks quickly and accurately. Moreover, the existing ant colony algorithm and genetic algorithm do not schedule some of the resources when scheduling resources, because they neglect some of the resources, resulting in a reduction in the resource utilization of parts recycling.

In the test of the time-consuming task, as the resource task increases, the task completion time of the proposed method is relatively stable compared to the other two comparison algorithms.

In the test of energy consumption in the resource scheduling process, the proposed method is lower in energy consumption than the other two comparison algorithms. This is mainly because the proposed algorithm uses directional particle swarm optimization to prepare the resource pheromone, which can avoid falling into the local optimal cycle, and can obtain the global optimal solution more easily, thus effectively reducing energy consumption.

In summary, the method proposed in this paper has more advantages than the existing methods in the effective utilization of resources, the time-consuming to complete recycling tasks, and the energy consumption in the process of resource scheduling.

5. Conclusions

Nowadays, “Energy saving and environmental protection, green development and win-win” has become the consensus of all sectors of society. It is of great importance and long-term practical significance to study the recycling, reusing and rational scraping of used automobile parts for saving resources and protecting the environment, and promoting the harmonious development between the green manufacturing and operation of automobiles and human society and nature. Aiming at the low resource utilization of used automobile parts recycling, this paper proposes a resource scheduling method based on improved reverse particle swarm optimization (IPSO) for parts recycling. By using adaptive mechanism, the degree of change of particle function is regarded as the factor of inertia weight updating, which accelerates the convergence rate of parts recycling resource scheduling, introduces the factor of particle reverse learning, and strengthens the ability of particle global search for parts recycling resources. In the future, we need to do further research on the information and data security mode of the scheduling model.

6. Acknowledgement

Funded by the youth innovation talents project of the Guangdong provincial department of education (humanities and social sciences): Research on recycling inventory management of express packaging and remanufactured products (2016WQNCX162).

Reference

[1] Xue, T.; Ma, T. Dynamic resource scheduling algorithm based on maximum resource utilization. Application Research of Computers, 2016, 33(5):1374-1378.

[2] Xiong, Y.; Jiang, J.; Zhang, Z. Z.; et al. Hybrid Resource scheduling algorithm with traffic differentiation in TWDM-PON. Acta Electronica Sinica, 2017, 45(6):1490-1497.

[3] Qiu, X. A. Novel scheduling algorithm based on utility function for LTE-A precoding system. Science Technology and Engineering, 2015, 15(6):215-219.

[4] Li, T. C.; Li, S. Y. Resource scheduling in cloud computing based on improved bat algorithm. Electronic Design Engineering, 2017, 25(1):43-46.

[5] Cui, J. M.; Liu, J. W.; Yang, C. Y. Resource scheduling algorithm based on priority queuing and network delay in cloud computation. Journal of Guilin University of Technology, 2017, 37(2):360-365.

[6] Wei, Y.; Chen, Y. Y. Cloud computing task scheduling model based on improved ant colony algorithm. Computer Engineering, 2015, 41(2):12-16.

[7] Chen, X. X.; Wu, H.; Wu, Y. W.; et al. Large-Scale resource scheduling based on minimum cost maximum flow. Journal of Software, 2017, 28(3):598-610.

[8] Liu, F.; Peng, Z. Y.; Gao, X. Simulation of port resource equilibrium scheduling model in cloud computing environment. Computer Simulation, 2016, 33(8):297-300.

[9] Ji, K. Cloud computing resource scheduling optimization based on ant colony algorithm with dynamic trend prediction. Bulletin of Science and Technology, 2016, 32(1):187-190.

[10] Xv, Z. J.; Chen, S. X. Research of fusion algorithm based on membrane computing and ant colony algorithm in cloud computing resource scheduling. Computer Measurement & Control, 2017, 25(1):127-130.

[11] Li, H. Y. Reverse supply chain coordination and incentive mechanism for automobile parts recycling and remanufacturing. Zhejiang University of Technology, 2016.

[12] Zhang, W. D.; Wang, Y. J.; Qin Z. C. An RNTP based coordinated resource allocation scheme in lte indoor scenarios. Journal of China Academy of Electronics and Information Technology, 2017, 12(3):241-245.

[13] Huang, H. Q.; Ye, X. M. Used auto parts recycling sorting process design. Highways & Automotive Applications, 2017, (3):13-16.

[14] Tong, J. H.; Liu, W. H. Comparative study on remanufacturing and recycling channels of auto parts. Machinery, 2016, 54(11):54-56.

[15] Meng, D.; Zhang, Q.; Luo, Y.; et al. An adaptive scheduling algorithm for ISAR imaging radar based on pulse interleaving. Journal of Air Force Engineering University (Natural Science Edition), 2017, 18(2):25-31.

[16] Wang, H. X.; Wang, Z. H.; Wen, G. F.; et al. Resource constrained multi-project scheduling based on adaptive particle swarm optimization algorithm. Journal of Industrial Engineering and Engineering Management, 2017, 31(4):220-225.

[17] Hu, Y. Research on used automobile recycling industry from the perspective of circular economy. Zhejiang University of Technology, 2016.

[18] Lei, M. N; Huang, X.; Wu, Y. C.; et al. Application of Evaporative Air Conditioner in a Large Space Automobile Factory in Xi'an. Journal of Xi'an Polytechnic University, 2018, (01):72-76

[19] Xia, C. L.; Yu, J. L. Study on Optimal Scheduling Modulation Control of Modular Multilevel Converter. Journal of Power Supply, 2015, 13(6):84-91.

[20] Xue, J. Potentials of the renewable resource of usedped cars in China. China's Population, Resources and Environment, 2013, 23(2):169-176.

[21] Upadhyay I.; Pandey G.N. Automated device for in-service monitoring of overhead pipes, burners and turbines in petrochemical plants. Open Journal of Mechanical Engineering, 2016, 1(1):1-7.

[22] Zhang, Z.; Wang, J. L.; Ren, X. F. Design of standard parts recycling system based on machine vision. Automation & Instrumentation, 2017, (8):32-33.

[23] Goswami S.; Choudhury A.; Das S., et al. Automated password protected door lock system. Advances in Industrial Engineering and Management, 2017, 6(1):48-52.