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Research on the Application of Intelligent Optimization Algorithm in Mechanical Design

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Abstract

Intelligent optimization algorithm belongs to a kind of emerging technology, show good characteristics, such as high performance, applicability, its algorithm includes many contents, including genetic, particle swarm and artificial neural network algorithm, compared with the traditional optimization way, these algorithms can be applied to a variety of situations, meet the demand of solution, in the mechanical design industry has wide application prospects. This paper analyzes the application of the algorithm in mechanical design and the comparison of the results to verify the significance of the intelligent optimization algorithm in mechanical design.

Keywords: intelligent optimization algorithm; mechanical design; application

1 Introduction

With the development of science and technology, the mechanical design is more complex, and the design difficulty is gradually increasing, and the traditional algorithm cannot meet the needs of mechanical design. Most of the traditional algorithms rely on manual design, which requires high time and cost. Through the application of intelligent optimization algorithm, related problems can be effectively solved. Intelligent optimization algorithm refers to the intelligent phenomenon displayed by the natural biological groups as the basis of the design activities, which can carry out self-evolution and adaptation.

2 The Application Significance of Intelligent Optimization Algorithm in Mechanical Design

Based on the development of social economy and the emergence of the trend of informatization, computer technology has played an important role in the processing of engineering problems. In recent years, the development of science and technology is characterized by the coordinated development of biology and engineering technology, which permeates each other and promotes the improvement of the teaching effect. Scholars and experts have created new algorithms, namely intelligent optimization algorithms, for the simulation of life science in studying natural phenomena. The algorithm involves many disciplines and belongs to the multi-disciplinary computational science, which has attracted the attention of experts and scholars. Due to its high efficiency and applicability, its application to mechanical design can provide new ideas for the solution of complex engineering problems and contribute to the effective solution of problems. At the same time, the algorithm has the advantages of versatility and robustness, in computer, engineering optimization and other fields, showing a good application prospect.

First, intelligent optimization algorithm contains many contents, such as simulating genetics, particle swarm and artificial neural network and annealing method of metal cooling. Compared with the traditional optimization method, the optimization method is highly adaptable, which can meet the design solution requirements under various links, and contribute to the improvement of design results.

Secondly, in the design link of engineering products, the intelligent optimization algorithm plays an important role, and it has been widely used since its inception. Through the development of the optimized design, the product can have good parameters, achieve the best quality size results, truly achieve the relevant goals, and reduce the investment. In the current environment, intelligent optimization algorithm has been applied in various industries, including national defense, construction, industrial machinery and petrochemical industry, etc., contributing to various industries and showing a vigorous development trend.

Finally, the optimized design has been widely used in mechanical design. Through the integration of this concept, it is conducive to the design of good mechanical

products, meet the requirements of various properties, and achieve better results. In the mechanical design activities, with the help of computer assistance, we can shorten the practice of scheme selection, select the optimal scheme in the shortest time, and promote the significant improvement of design efficiency. In the process of mechanical optimization design, tend to design to the mathematical theory content, prone to local optimal value and the target function has higher requirements, and the traditional optimization way, cannot meet the requirements of the design of various conditions, with the help of intelligent optimization theory, can solve the problems of traditional optimization, good mechanical design effect.

3 The Theoretical Basis of the Intelligent Optimization Algorithm

Intelligent optimization algorithm is based on the nature, research activities, the character content, in the simulation of natural phenomena and laws, gradually derived a variety of bionic algorithms. In addition, in the intelligent optimization algorithm, mathematical theory belongs to the basis, can adopt computer technology, the solution of a group of problems set as the initial, according to the solution parameters of the problem, according to the relevant provisions, to carry out operational activities. Different from the traditional optimization algorithm, the intelligent optimization algorithm belongs to the probability search method, which has obvious advantages: the algorithm can be optimized according to the value of the objective function to escape the influence of the differentiability of the objective function; the algorithm is not affected by the central constraint and will not affect the overall problem due to individual operators, which can guarantee the system robustness; it has a broad applicable scope and can carry out large-scale operation. In the intelligent optimization algorithm, genetic, particle swarm and annealing algorithms have been widely used. The main algorithm studied in this paper is genetic and particle swarm algorithm, which provides guarantee for the subsequent research by analyzing its characteristics.

3.1 Genetic algorithm

American Holland first proposed the genetic algorithm in 1975, and the algorithm mainly comes from the research of biological systems, using the computer simulation in the process of research. Genetic algorithm is mainly through the biological evolution, genetics, the formation of technology model, with the simulation of natural evolution process, form the best quality solution, belongs to the efficient search way, can guarantee the global search, the way can be through the way of automatic search, analysis of spatial information, and get the optimal solution. Genetic algorithm mainly follow the related principles of nature, namely the principle of

survival of the fittest, by coding the characters and code for chromosome, and the composition of each population for N individuals, and individual formed by string structure, the individual become the research object of genetic algorithm, can carry out efficient search activities in the parameter space, operating random optimization.

In addition, genetic algorithms do not need the help of auxiliary information. The algorithm has a good fitness function, which breaks the limit of continuity and differentiability, and can evaluate the optimal unit with the help of the fitness function. At the same time, at the same time, it can set a wide range of value categories, break the constraints of the operation, and promote the expansion of the application scope.

3.2 Particle swarm algorithm

American James Kennedy and Russell Eberhart formally proposed the concept of particle swarm algorithm in 1995. The algorithm is mainly based on the predation of birds, and it belongs to a random search method based on group collaboration, and shows a good application prospect. Particle swarm algorithm is to find the best solution by using the cooperative activities of groups and individuals, so as to find the optimal solution.

# 4 Application of Intelligent Optimization Algorithm in Mechanical Design

4.1 The application of the intelligent optimization algorithm in the traction machine

In the process of elevator operation, the traction machine plays an important role, belongs to the mechanical transmission facilities, there are widely used, in the current era, the traction machine has some shortcomings, such as large volume, large transmission ratio, resulting in the actual mechanical efficiency is poor. Therefore, in order to improve the mechanical efficiency and reduce the power consumption, in the research field of traction machine, the light quality, high efficiency and strong bearing capacity have become the main direction. However, in addition to optimizing the materials and processing methods of tractors, it is also necessary to pay attention to the adjustment of optimization methods, optimize the design of tractors, and ensure the good development of tractors.

For example, the tractor adopted by an elevator is selected as a case, and according to the ordinary cylindrical worm reducer, including input power (P 1 5.5 Kw), rotation speed (n11400 r/min), load coefficient (K 1.1) and transmission ratio (i 20). In addition, the worm material is selected as low carbon alloy steel, the turbine material is cast tin bronze, and the allowable stress of the turbine gear ring in the tractor is 220MPa. In the optimization, it is necessary to clear the optimization goal, meet the strength, stability and stiffness of all

parties as the basis, pay attention to the adjustment of mechanical design, so as to realize the reduction of the turbine tooth ring, reduce the material input, and improve the work efficiency of the traction machine.

Through the arrangement of target and constraint functions, the algorithm program can be written, including particle swarm algorithm and legacy particle swarm algorithm. Multiple programming and debugging activities can obtain stable results and ensure normal output. The specific results are shown in Figure 1 and Figure 2.
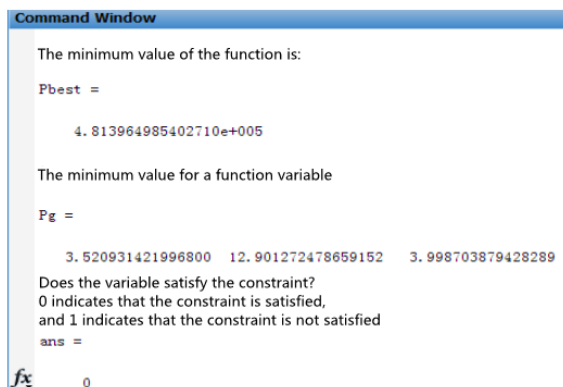
Figure 1 Pswarm algorithm results
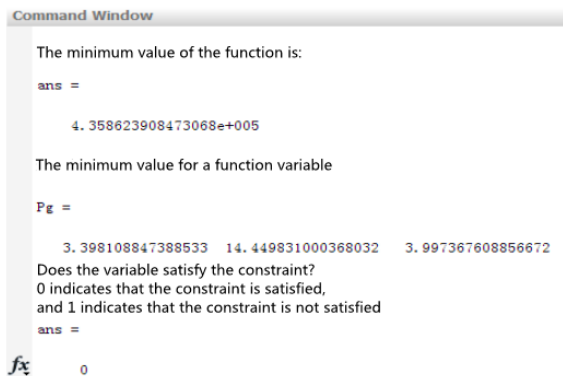
Figure 2 Heritage particle ensemble combined with the algorithm results

Take the way of comparison, you can select the best optimization effect of the algorithm. By comparing the results of traditional optimization, particle swarm and genetic particle swarm combined with algorithms (such as Table 1), it is not difficult to draw the following conclusions: the conclusion of intelligent optimization algorithm is obviously better than the results of traditional optimization methods. Compared with the traditional optimization way, the particle swarm results are roughly lower than the traditional algorithm 27 percent, genetic particle swarm combining the results of roughly lower than the traditional algorithm, according to the table of the data analysis, can find the intelligent optimization algorithm applied to the design link, can effectively optimize the turbine volume, although the genetic and particle group algorithm has good optimization results, but the best optimization algorithm is genetic particle swarm algorithm, the application of mechanical design link, can significantly improve the design effect.

4.2 Application of intelligent optimization algorithm in spring

In the mechanical industry spring has a very wide application, belongs to the important connection part of mechanical equipment, instruments and other items, belongs to a kind of elastic elements. Spring has a unique elastic function, can accept load after elastic deformation, when eliminate load, the spring can return to the original state, in the process of spring deformation, realize the mechanical energy, elastic potential energy and kinetic energy conversion, at the same time because of its characteristics, meet the demand of all kinds of machinery. In the process of spring optimization design, the key contents are the number of spring coil, spring wire and medium diameter. Through the optimization design activities of the above parameters, the design objectives are clear, the focus is on reducing the weight of the spring, and the cost reduction is realized.

For example, you can select a spring to apply to an elevator speed limiter as a case to identify all kinds of data of the spring, including diameter (44mm) and maximum stiffness (K_{max}24 N/mm), allowable stress (665 Mpa) and the maximum working pressure (F_{max}1120N) .At the same time, when optimizing the design of the spring, it is necessary to identify the best spring working ring (n), spring diameter (d) and spring diameter (D) from the required perspective.

By sorting out the target and constraint functions, and writing relevant programs, including particle swarm algorithm and genetic particle group combination, programming and debugging activities, the stability of the output operation results is finally guaranteed. The specific results are shown in Figure 3 and Figure 4.

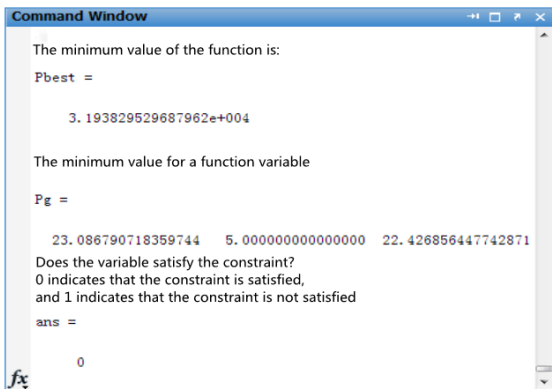**Table 1** Comparison of the algorithm results

optimization method	Number of worm heads, z_1	modulus m mm	Diametral quotient q	volume V mm^3
Traditional optimization method	3	5	8	692436.2344
particle swarm optimization	4	3.5	14	507635.8750
Genetic particle swarm combination algorithm	4	3.5	13	475908.6330

Optimization method	Number of effective coils n	The reed diameter d mm	In the spring through d mm	Volume v mm³
Traditional optimization method	15	6	36	47963.4481
Particle swarm optimization	27	5	22	36638.7451
Genetic particle swarm combination algorithm	23	5	23	32629.4548
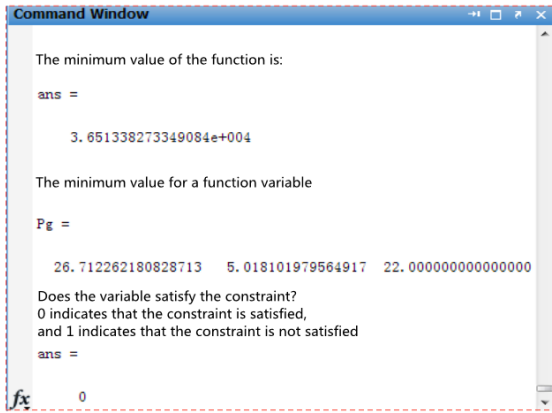
Figure 3　Pswarm algorithm results

Figure 4　Combined algorithm results of legacy particle groups

Through the algorithm comparison, the final solution results are obtained, including traditional optimization, the combination of genetic particle groups and particle group. The specific display is shown in Table 2. Through the development of relevant data analysis, it is not difficult to find the application of intelligent optimization algorithm, and the results are significantly better than the traditional methods. By carrying out comparative activities with the traditional way, it can be concluded that compared with the traditional algorithm, the particle group is reduced by nearly 24%, and the combination of genetic particle group is reduced by nearly 32% compared with the traditional algorithm. According to the above results, it can be found that the intelligent optimization algorithm can achieve good results in the application process of spring volume optimization. Although the genetic and particle swarm algorithm have good optimization results,

the most obvious effect is still the genetic particle swarm combination algorithm proposed in this paper.

5 Conclusion

To sum up, under the background of the information age, the machinery industry has ushered in the opportunities and challenges of development. In order to better seize the opportunities and meet the challenges, it is necessary to pay attention to the optimization of mechanical design and change the previous algorithm form. This paper discusses the application effect of intelligent optimization algorithm, and takes the traction machine and spring as cases. Compared with previous optimization algorithms, intelligent optimization algorithm has outstanding advantages in search, design and other aspects. The application of this algorithm in mechanical design is helpful to optimize the design effect. Among them, the intelligent optimization algorithm has more prominent advantages, which can be better optimized and achieve good results. A new genetic particle swarm combination algorithm is proposed to achieve outstanding results in mechanical design.

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