The Research of Sheet Size Precision Based on Optimization Algorithm Of Chaos Immune

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Keywords: size precision ; boron steel; optimization algorithm; chaos immune

Abstract. The chaos optimization algorithm and immune algorithm are combination of their respective characteristics, which is a chaos immune algorithm. The test results show that the algorithm not only keeps population diversity, also better and faster convergence speed and search ability. The influence cause of boron steel sheet on size precision is studied, which is contained with additional drawing stress, emergency ratio, board deep, plastic modulus, subdued point, sclerotic index, crushing force, curvature radius and so on .In order to lay the further foundations of optimizing design, it is analyzed that the latent relation of influence cause of boron steel sheet on size precision by orthogonal experiment. It is pointed orderly out that the influences with rebound result of certain automobile back wheel casing are that sheet crushing force occupies the first place, sheet thick comes second, and sclerotic index comes third, emergency ratio and curvature radius in order.

1 Introduction

Immune algorithm has the characteristics of automatic antigen recognition, feature extraction, the antibody diversity, distributed detection, learning and memory, self planning etc. The solution efficiency is not high between the neighborhood search to satisfied. Chaos optimization algorithm is to ask questions of the variable to the chaotic space from the solution space transformation, and then search to satisfactory solution to use the randomness of chaotic variables, the regularity and characteristics of ergodic, it is characteristics of sensitive to initial value, easy to jump out of local minimum point, search speedly and global convergence steps. Its disadvantage is that when the search space is large, the effect is not obvious. And the chaos optimization algorithm and immune algorithm are combination of their respective characteristics, which is a chaos immune algorithm. The test results show that the algorithm not only keeps population diversity, also better and faster convergence speed and search ability.

The lightweight is the current mainstream of car industry development, the 22 MnB5 of boron alloy steel is with rapid cooling characteristics , it can produce complex shape and resistance to the collision parts. AHSS/UHSS will not only cause bigger bending and distortion, and still have serious side curly in processing. the spring back control of AHSS/UHSS puts forward a new challenge on the forming process [1]~[4] .

2 Principle of Chaos Immune Algorithm

Consider the following optimization problem: n is for the number of optimization variables. Type (1) is done as variable optimization function, type (1) is to optimize the conditions.

Under the convenience, it is given to use the type generating chaotic sequence.

$$Z_{k+1} = \eta Z_k (1 - Z_k) \tag{1}$$

Among them, the chaotic variables K is done as the chaotic iterations, as control parameters. It is determined the randomized.

$$\beta_k^{'} = (1-\alpha)\beta^{*} + \alpha \beta_k \tag{2}$$

Among them, it is for the current optimal values mapped to [0, 1], after the formation of the vector, and it is as the optimal obfuscation vector; K is for iteration times chaotic vector. As the chaos is after applying stochastic disturbance vector; and it is decrease with the decrease of the change with variable.

$$\alpha = 1 - \left| \frac{k-1}{k} \right|^{p} \tag{3}$$

P is as an integer of the objective function; K is for the number of iterations, here it takes evolution algebra.

The main steps of chaos immune algorithm are as follows. The first sets up the genetic population size n, memory population size L, immune select threshold Ti, crossover rate Pc and mutation rate Pm, termination conditions Sc. Step 2 is to build random memory solutions for individuals and populations genetic L, random solution and the initial population. Step3 is to calculate each individual expectation reproduction rate. It calculates the similarity between antibodies, among them, it is for the antibody information entropy, and which is antigen and antibody affinity, antibodies of population ratio is calculated, among them, which is to calculate the antibody expectation reproduction rate.

$$s_{gh} = \frac{1}{H(g,h)} \; A_g = f(x_g); \tag{4}$$

$$R_g = \frac{1}{n+m} \sum_{h=1}^{n+m} Q_{gh} \tag{5}$$

Step 3 is to create a new generation of population. Expectation reproduction rate is the individual descending order, according to size,. Taking the first n is as individual populations genetic, before L individual populations is memory Banks. Step 4 is to chaos optimization, memory population is including chaos optimization of individual choice, solution space is mapped to the chaotic space, to press type (3), the chaos iteration is a chaotic space mapping to the solution space, that is chaos disturbance. Step 5 is to determine whether meet the end conditions, if meets, it is over. Step 6 is to generate new solutions group. Step 8 is to go back to step 3. Example trials is as follows. Application of chaos immune genetic algorithm is proposed in this paper, the following three test function optimization algorithm is on the effectiveness of optimization computation.

To test the effectiveness of the algorithm, this paper will be the result of the chaos immune genetic algorithm, comparing with the results of the genetic algorithm and immune algorithm, the population is 40, memory population is 14, immune domain value is of 0.85, and the mutation probability is 0.05, all kinds of algorithms are tested 20 times. The results are shown in Tab.1, which is suitable for individual function value and optimal value function.

Tab. 1 The result of compared with the immune and Chaos immune algorithm

Function	Immune algorithm			Chaos immune genetic algorithm		
	Termination conditions	number	time	Termination conditions	number	time
F_1	f- f_b <1e-4	3724	1253.2	f- f_b <1e-4	2931	1026.1
F_2	f- f_b <5e-4	8266	2012.3	f- f_b <5e-4	7185	1582.2
F_3	f- f_b <1e-6	459	183.6	f- f_b <1e-6	231	97.2

The results show that the convergence of genetic algorithm and immune algorithm are poorer, to get satisfaction value more difficult. The search ability of chaos immune genetic algorithm is much better than genetic algorithm and immune algorithm, because the chaos immune genetic algorithm is a combination of genetic algorithm and immune algorithm, search space is to advantage, quickly to jump out of local minimum point. Obtain extremum time is much less than genetic algorithm and immune algorithm.

3 The main factors of effect analysis of boron alloy steel plate size precision

3.1 The influence of the deformation and deformation character of the cover sheet sizes. A car rear cover drawing parts is for example, when the force of blank bigger, by tension and strain bigger than board surface strain yield, the quantity of stamping was decreased. the spring back quantity of blank after the plane strain state of the deformation is smaller than the spring back quantity of double drawing state after deformation[5] .

3.2The influence of the distribution deformation and bending radius of a sheet sizes. When a sheet cover sizes is in rounded and other parts with bending deformation as the main deformation of the way , the smaller the bending radius, the greater plastic deformation, the smaller the spring back , the easier size accuracy improved.

3.3The influence on the performance of the cover parts sheet sizes. The thicker of the blank covering parts and the smaller spring back are seen Fig.1. The main influence performance parameters of covering parts size precision have yield limit σs , elastic modulus E and plastic modulus E1, hardening exponent n, thick anisotropic coefficient r, etc. A car rear cover drawing parts is as an example, the higher is the σs of materials , the deformation of the elastic recovery, the greater elastic modulus E and plastic modulus E1, the smaller the elastic recovery ,the bigger of materials N value, the smaller the elastic recovery,it is seen from Fig. 2, Fig. 3 and Fig.4, the influence of R value is not too rules, but the two way and r value greater than 1, the bigger the r value material, the smaller the spring back.

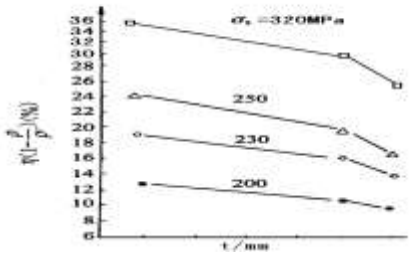

Figure1. Influence of board deep to rebound of boron and general steel

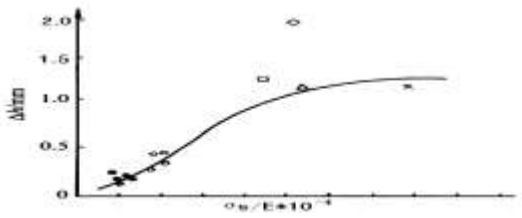

Figure 2. Influence of σs / E to rebound of boron

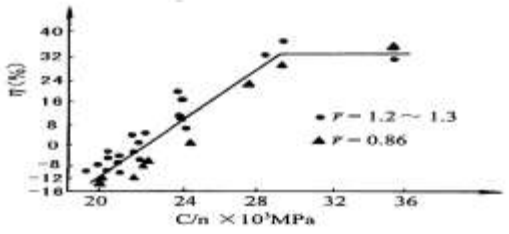

Figure 3. Influence of E1 to rebound of boron steel

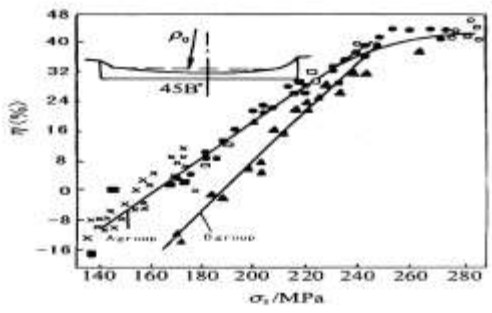

Figure 4. Relation of σs with rebound in fleet drawing of boron steel

4 Conclusions

The chaos optimization algorithm and immune algorithm are combination of their respective characteristics, which is a chaos immune algorithm. The test results show that the algorithm not only keeps population diversity, also better and faster convergence speed and search ability. The influence cause of boron steel sheet on size precision is studied, which is contained with additional drawing stress, emergency ratio, board deep, plastic modulus, subdued point, sclerotic index, crushing force, curvature radius and so on .In order to lay the further foundations of optimizing design, it is analyzed that the latent relation of influence cause of boron steel sheet on size precision by orthogonal experiment. It is pointed orderly out that the influences with rebound result of certain automobile back wheel casing are that sheet crushing force occupies the first place, sheet thick comes second, and sclerotic index comes third, emergency ratio and curvature radius in order.

References

[1] T. Tröster and W. Rostek, Advanced Hot Forming, in proceedings from The International Conference New Development in Sheet Metal Forming Technology, Stuttgart, Germany (2004), p. 49-63.

[2]. R. Kolleck et al, Hot Forming and Cold Forming Two Complementary Processes for Lightweight Auto Bodies, in proceedings from The International Conference New Development in Sheet Metal Forming Technology, Stuttgart, Germany (2004), p. 235-244.

[3] WenWeiDong, Prediction model based on the fuzzy reliability . aircraft engine . In 2004, (3) : 322-323.

[4] LiuZhanJun. Difficulty reliability prediction research of titanium plate stamping forming based on the fuzzy control. Beijing: plastic engineering journal, 2005 (6) : 63-66.

[5] Zhao Zhiheng, Li Jianhui sasihorfswe;Electromagnetic forming force [J];Journal of plastic engineering, 2001