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Optimal Design of Ship Based on MDO

Jingzheng Yao[1+], and Duanfeng Han[2]

[1]Multihull Ship Technology Key Laboratory of Fundamental Science for National Defence, Harbin Engineering University, Harbin 150001, China

[2]College of Shipbuilding Engineering, Harbin Engineering University, Harbin 150001,China

Abstract. Design method for ship by multi-disciplinary design optimization is proposed in the paper. Design model for ship by multi-disciplinary design optimization are created and the process of design model for ship by traditional design technology is given. Design model for ship by traditional design technology is created to compare with multi-disciplinary design optimization. In the design model for ship, genetic algorithm is applied to design optimization here, among which the target function is composed of the parameters including ship speed, drag calculation, stability, weight, volume of compartment and operability. The experimental results show that design model for ship by multi-disciplinary design optimization is better than traditional design technology.

Keywords: optimal design; ship; MDO; genetic algorithm

1. Introduction

It is well-known that multi-disciplinary design optimization (MDO) is a very excellent design technology [1-3]. Thus, design model for ship by multi-disciplinary design optimization is proposed. In the paper, design model for ship by traditional design technology and multi-disciplinary design optimization are created. In the design model for ship, genetic algorithm[4,5] is applied to design optimization here, among which the target function is composed of the parameters including ship speed, drag calculation, stability, weight, volume of compartment and operability. The experimental results show that design model for ship by multi-disciplinary design optimization is better than traditional design technology.

2. Design Model For Ship By Multi-Disciplinary Design Optimization

Design model for ship by traditional design technology and multi-disciplinary design optimization are introduced in the section respectively. In the design model for ship, genetic algorithm is applied to design optimization in the paper.

2.1. Design Model for Ship by Traditional Design Technology

Design model for ship by traditional design technology is introduced here. The process of design model for ship by traditional design technology is shown in Fig.1,which is described as followings:

Step 1 Give design assignment book which includes *DWT*(loading capacity),*V*(navigational speed), *T*(draught), *VC*(volume of compartment).

Step 2 Initialize main scale: *L* (length of ship),*B*(width of ship),*D*(molded depth) and block coefficient C_b.

Step 3 Code *L* (length of ship),*B*(width of ship),*D*(molded depth) and block coefficient C_b.

Step 4 Create a population of chromosome randomly.

+ Corresponding author. Tel.: +86-13074536078
E-mail address: yaojingzheng@yeah.net

Step 5 Evaluation fitness function. The target function is composed of the parameters including ship speed, drag calculation, stability, weight, volume of compartment and operability.

Step 6 New chromosome is generated by using selection, crossover and mutation operations. Selection operation can select optimal chromosome to reserve, crossover operation can exchange parts of the two chromosomes to produce two new chromosomes and mutation operation alters internal representation of one chromosome to produce the new chromosome.

Step 7 If minimum fabrication cost isn't obtained, new chromosome is generated. Otherwise, ship main scale and ship form coefficient are obtained.

2.2. Design Model for Ship by Multi-disciplinary Design Optimization

Design model for ship by multi-disciplinary design optimization is introduced here. The process of design model for ship by multi-disciplinary design optimization is shown in Fig.2, which is described as followings:

Step 1 Give design assignment book which includes *DWT*(loading capacity),*V*(navigational speed), *T*(draught), *VC*(volume of compartment).

Step 2 Initialize main scale: *L* (length of ship),*B*(width of ship),*D*(molded depth) and block coefficient C_b.

Step 3 Ship main scale, ship form coefficient, ship afterbody lines are gained by calculating ship form harmonic model hydrostatic force.

Step 4 Code *L* (length of ship),*B*(width of ship),*D* (molded depth) and block coefficient C_b.

Step 5 Create a population of chromosome randomly.

Step 6 Evaluation fitness function. The target function is composed of the parameters including ship speed, drag calculation, stability, weight, volume of compartment and operability.

Step 7 New chromosome is generated by using selection, crossover and mutation operations. Selection operation can select optimal chromosome to reserve, crossover operation can exchange parts of the two chromosomes to produce two new chromosomes and mutation operation alters internal representation of one chromosome to produce the new chromosome.

Step 8 If minimum fabrication cost is obtained, the procedure ends, and ship main scale, ship form coefficient and ship afterbody lines are obtained.

3. Experimental Analysis And Application

Design model for ship by traditional design technology and multi-disciplinary design optimization are created. In the design model for ship, genetic algorithm is applied to design optimization in the paper, among which the number of chromosome is 20. The rate of crossover operation is 0.8 and the rate of mutation operation is 0.01. The target function is composed of the parameters including ship speed, drag calculation, stability, weight, volume of compartment and operability. The optimal process by genetic algorithm is shown in Fig.3.

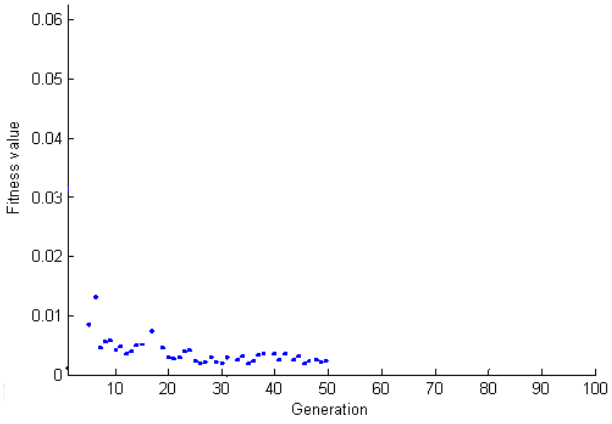

Fig 3: The optimal process by genetic algorithm

Ship main scale and ship form coefficient are obtained by traditional design technology, and ship main scale, ship form coefficient and ship afterbody lines are obtained by multi-disciplinary design optimization. The experimental results show that design model for ship by multi-disciplinary design optimization is better than traditional design technology.

4. Conclusion

In the paper, design model for ship by multi-disciplinary design optimization is proposed. In the design model for ship, genetic algorithm is applied to design optimization here, among which the target function is composed of the parameters including ship speed, drag calculation, stability, weight, volume of compartment and operability. Design model for ship by traditional design technology is created to compare with multi-disciplinary design optimization. The experimental results show that design model for ship by multi-disciplinary design optimization is better than traditional design technology.

5. References

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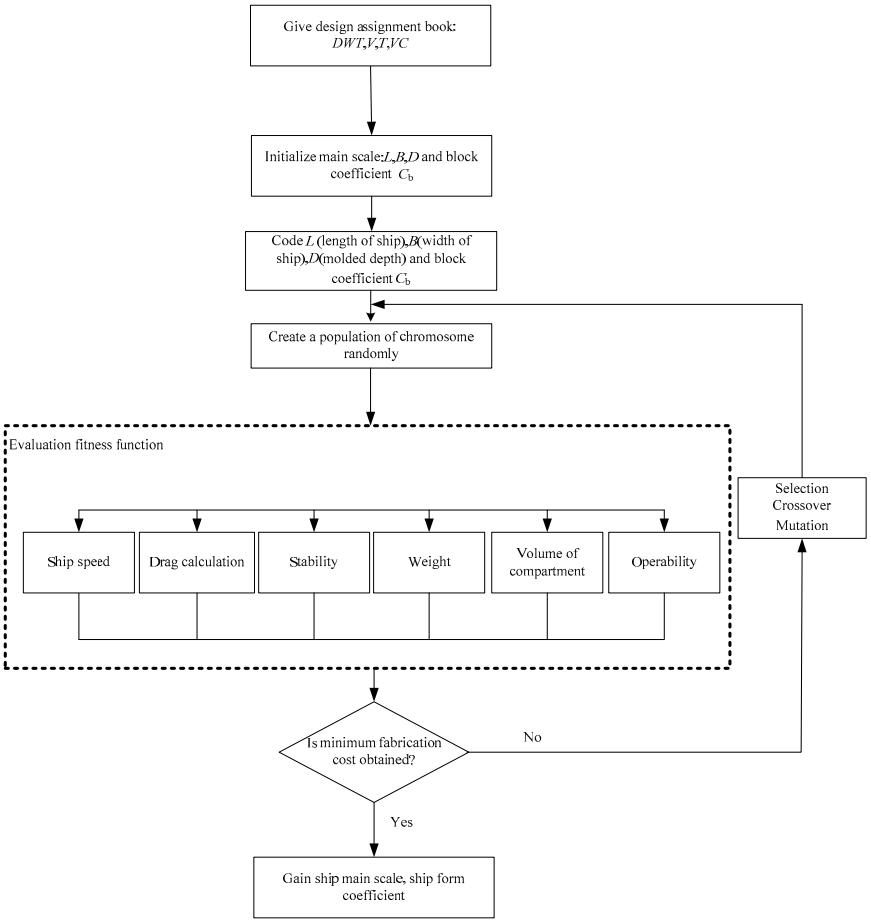

Fig 1: The process of design model for ship by traditional design technology

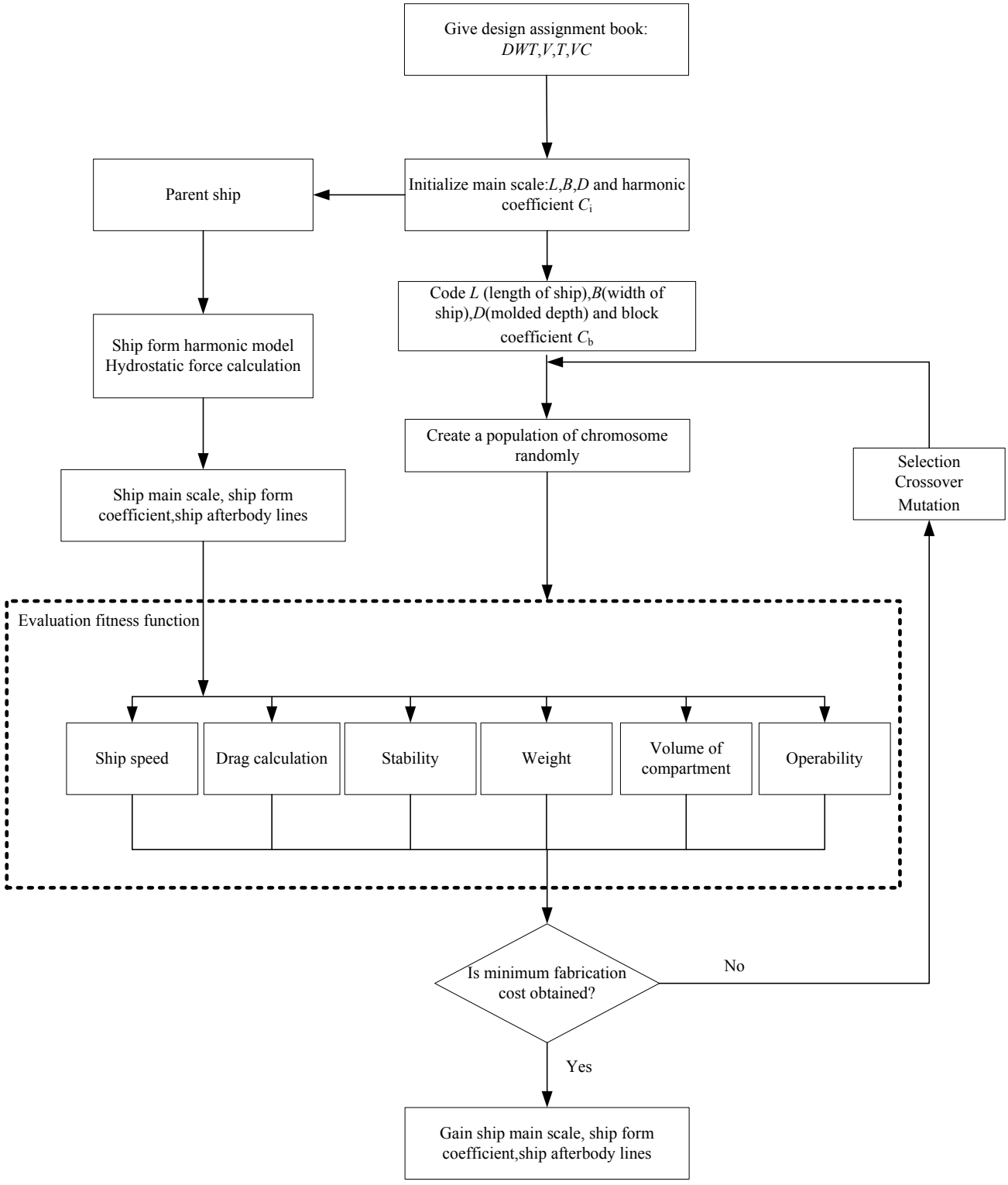

Fig. 2: The process of design model for ship by multi-disciplinary design optimization