2012 International Conference on Computer Technology and Science (ICCTS 2012)
IPCSIT vol. 47 (2012) © (2012) IACSIT Press, Singapore
DOI: 10.7763/IPCSIT.2012.V47.58

RBF Neural Network Evaluation Model for MDO Design of Ship

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Abstract. Multi-disciplinary design optimization (MDO) is a very excellent ship design technology. The intelligent method is usually introduced to evaluate the design effects of MDO. In the paper, RBF neural network evaluation model for MDO design of ship is proposed. Firstly, evaluation model for traditional design technology and multi-disciplinary design optimization (MDO) by RBF neural network are introduced respectively. Then, the RBF neural network evaluation model for traditional design technology and RBF neural network evaluation model for multi-disciplinary design optimization (MDO) are established respectively. It is indicated that the fabrication cost gained by RBF neural network evaluation model for multi-disciplinary design optimization is lower than that gained by RBF neural network evaluation model for traditional design technology.

Keywords: design evaluation; ship; RBF neural network; MDO

1. Introduction

Multi-disciplinary design optimization (MDO) is a very excellent design technology[1], which has a wide application in the ship design. In order to evaluate the design effects of MDO, the intelligent method is introduced. RBF neural network is a type of forward-feed neural network. Radial basis function (RBF) in the hidden layer is employed in the RBF neural network[2,3]. RBF neural network has better generation ability than BP neural network[4].

Thus, RBF neural network evaluation model for MDO design of ship is proposed in the paper. The RBF neural network evaluation model for traditional design technology and RBF neural network evaluation model for multi-disciplinary design optimization (MDO) are established respectively. The experimental results show that the fabrication cost gained by RBF neural network evaluation model for multi-disciplinary design optimization is lower than that gained by RBF neural network evaluation model for traditional design technology.

2. Design evaluation model for ship based on rbf neural network

2.1. RBF Neural Network

RBF neural network is a type of forward-feed neural network. In the RBF neural network, radial basis function (RBF) in the hidden layer is employed. RBF neural network has better generation ability than BP neural network. However, the centers and the widths of RBF and the output weights have a certain influence on the generation ability of RBF neural network. Therefore, genetic algorithm is employed to choose the centers and the widths of RBF and the output weights. The detailed steps of RBF neural network selected by genetic algorithm are given as followings:

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Step1 Code the parameters of RBF neural network which include the centers and the widths of RBF and the output weights and the chromosome composed of the centers and the widths of RBF and the output weights is gained.

Step2 Define the fitness function which is used to evaluate each chromosome.

Step3 New chromosome is generated by using selection, crossover and mutation operations.

Step4 Judge the stopping condition. If the stopping condition is satisfied, the suitable parameters including the centers and the widths of RBF and the output weights are obtained.

2.2. Design Evaluation Model for Ship by RBF Neural Network

Firstly, evaluation model for traditional design technology and multi-disciplinary design optimization (MDO) by RBF neural network are introduced respectively. The process of the evaluation for traditional design technology by RBF neural network is shown in Fig.1 and the process of the evaluation for multi-disciplinary design optimization (MDO) by RBF neural network is shown in Fig.2. In the evaluation for traditional design technology by RBF neural network, design assignment book which includes *DWT*(loading capacity),*V*(navigational speed), *T*(draught), *VC*(volume of compartment) is given. Then, initialize main scale: *L* (length of ship),*B*(width of ship),*D*(molded depth) and block coefficient C_b, which are used as the input features of RBF neural network model. And the fabrication cost is the output of RBF neural network model. If minimum fabrication cost isn't obtained, new design assignment book is gained by optimizer. Finally, ship main scale, ship form coefficient is obtained. In the evaluation for multi-disciplinary design optimization (MDO) by RBF neural network, design assignment book which includes *DWT*(loading capacity),*V*(navigational speed), *T*(draught), *VC*(volume of compartment) is given. Then, initialize main scale: *L* (length of ship),*B*(width of ship),*D*(molded depth) and harmonic coefficient C_i. Ship main scale, ship form coefficient, ship afterbody lines are gained by calculating ship form harmonic model hydrostatic force, which are used as the input features of RBF neural network model. And the fabrication cost is the output of RBF neural network model. If minimum fabrication cost isn't obtained, new design assignment book is gained by optimizer. Finally, ship main scale, ship form coefficient, ship afterbody lines are obtained.

3. Case Analysis Ang Application

The design of tankship with 9000T is applied as our experimental case. The RBF neural network evaluation model for traditional design technology is shown in Fig.3. *L* (length of ship),*B*(width of ship),*D*(molded depth) and block coefficient C_b are used as the input features of RBF neural network model and the fabrication cost is the output of RBF neural network model. The RBF neural network evaluation model for multi-disciplinary design optimization (MDO) is shown in Fig.4. Ship main scale, ship form coefficient, ship afterbody lines are used as the input features of RBF neural network model and the fabrication cost is the output of RBF neural network model.

By the constraint conditions met, the fabrication cost by using traditional design technology is 7.1 million yuan RMB;and the fabrication cost by using multi-disciplinary design optimization is 6.5 million yuan RMB.

The experimental results show that the fabrication cost gained by RBF neural network evaluation model for multi-disciplinary design optimization is lower than that gained by RBF neural network evaluation model for traditional design technology.

4. Conclusion

RBF neural network evaluation model for MDO design of ship is proposed in the paper. RBF neural network is a type of forward-feed neural network. Radial basis function (RBF) in the hidden layer is employed in the RBF neural network. RBF neural network has better generation ability than BP neural network. We establish the RBF neural network evaluation model for traditional design technology and RBF neural network evaluation model for multi-disciplinary design optimization (MDO) respectively. The experimental results show that the fabrication cost gained by RBF neural network evaluation model for MDO is lower than that gained by RBF neural network evaluation model for traditional design technology.

5. Reference

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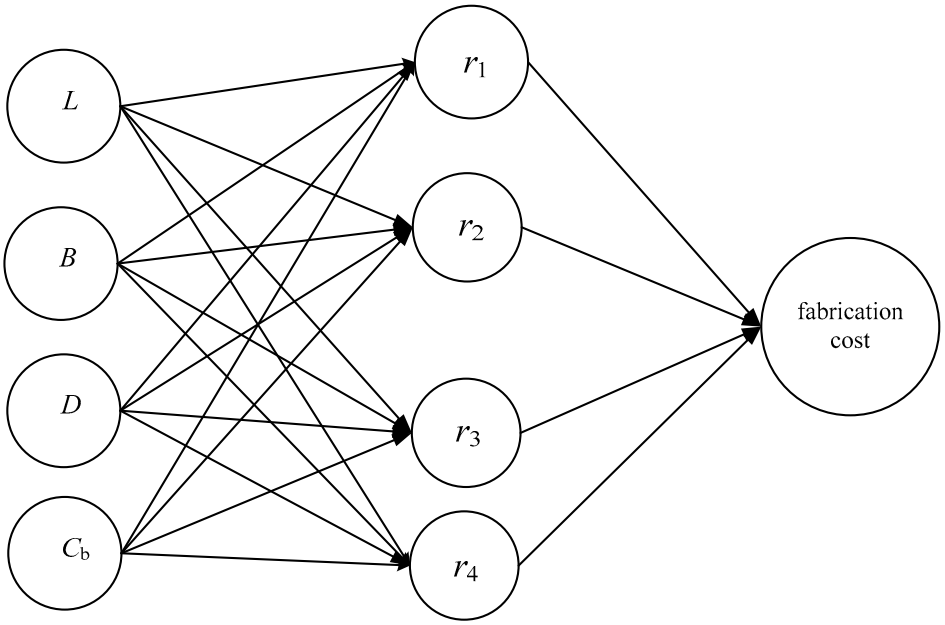

Fig.3: The RBF neural network evaluation model for traditional design technology

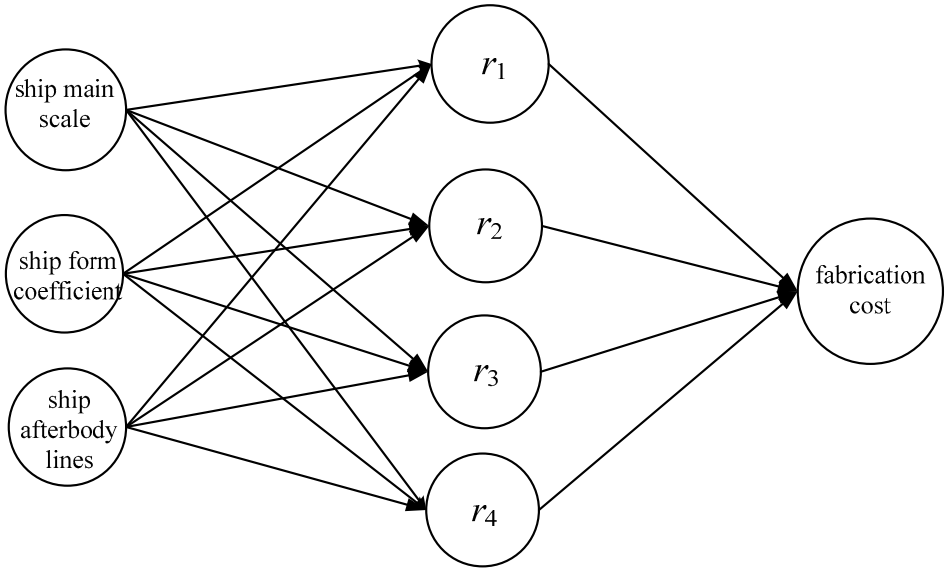

Fig.4: The RBF neural network evaluation model for multi-disciplinary design optimization (MDO)

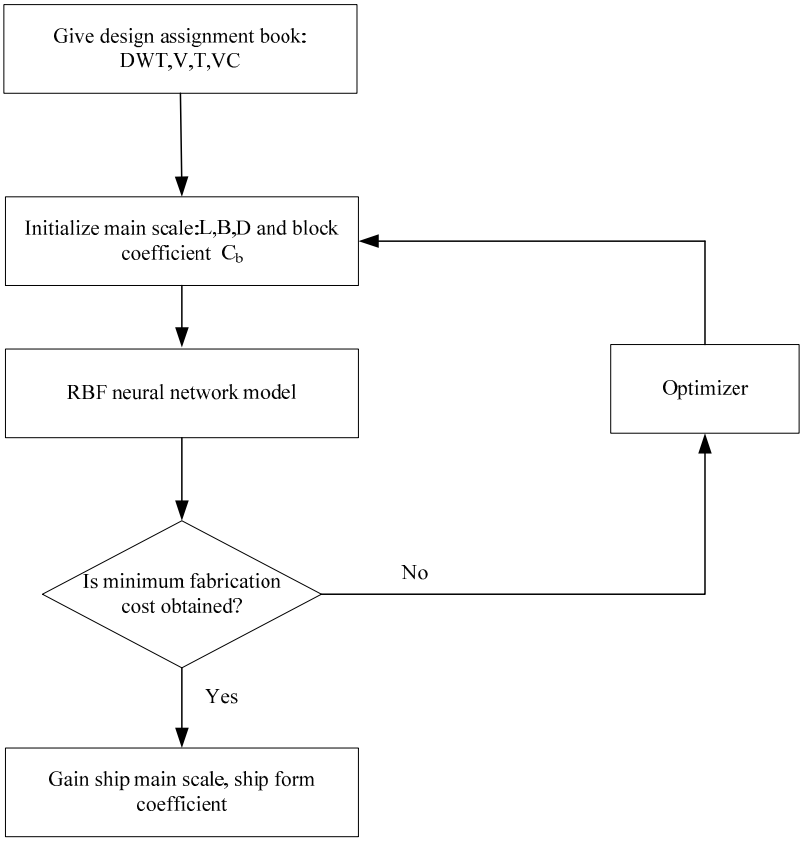

Fig.1: The process of the evaluation for traditional design technology by RBF neural network

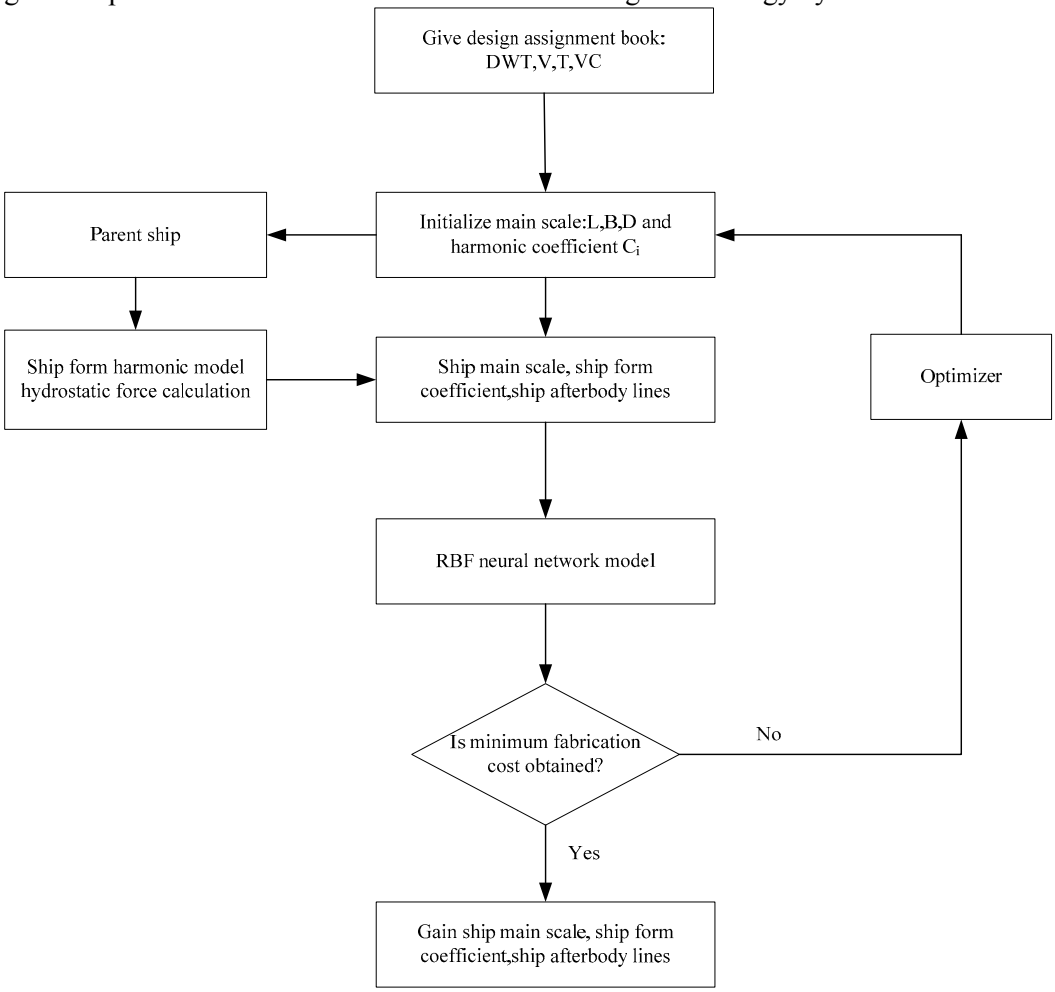

Fig.2: The process of the evaluation for multi-disciplinary design optimization (MDO) by RBF neural network