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Rapidity and maneuverability optimization analysis of submersible vehicle based on particle swarm optimization

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Optimization is an important part of the design on submersible vehicle. In order to determine the influenced degree of design variables, studying the sensitivity of variables to optimized system is becoming important. In this paper, the AUV of AUTOSUB type was the object of research. The RSM method was used to construct response surface and establish a response surface equation between independent variables and dependent variable, which can provide basis for the establishment of optimized system and also can reduce the amount of computational cost, as well as effectively ensure the accuracy of the calculation.

In order to establish the optimized system, three response surfaces have been established, which are the basis for solving the problems encountered in the design, and the final design of the optimized system can be realized by particle swarm which has the advantages of simpleness, easy to implement, without gradient information, fewer parameters and so on.

In this paper, a comprehensive optimization system of rapidity and maneuverability has been established through constructing mathematic model and writing optimization algorithm. Twenty-six design variables have been selected and six constraint conditions have be established in this paper. The overall objective function has been established by eight sub-objective functions, which include the parts of rapidity and maneuverability. The particle swarm optimization algorithm based on the response surface method has been constructed to study the sensitivity of six design variables, which provides reference for the further optimization.

Considering the characteristic of each variable, six variables have been selected to take a research on the sensitivity of these variables to the optimized system. And the design variables include the length of bow, the length of middle body, the length of stern, the molded breadth, the molded depth, the propeller diameter and rotational speed of propeller, when the design speed is 3kn.

The results show that different design variables have different sensitivity to the optimized systems. The length of bow, length of middle body and the molded breadth have a higher sensitivity and the length of stern have a low sensitivity on the rapidity system. Similarly, the length of bow , molded breath, the diameter of propeller and the rotational speed have a higher sensitivity on the maneuverability system. Comparing the overall objective function, the lengths of bow and middle body have a higher sensitivity on the overall optimized system. So, the accuracy can be improved further through selecting the sensitive variables to parallelly divide and optimizing further.

Analyzing the results, the rapidity objective function account for a higher percentage of the overall objective function, which reflects that the design of the rapidity system is the key part of the design of the optimized system. On the other hand, using response surface method simplifies the optimized system, which can provide an idea for solving the optimized problems of multiple objectives, multiple variables and multiple constraints.

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