Nonlinear Analysis of Airship Envelop Aerolasticity

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Abstract

The large airship in flow field is a flexible body with low rigidity. The distribution of the peripheral flow field around the airship is closely related to its shape. It is essentially one of the Fluid-structure Interaction problems. Based on this, this paper aims at the numerical simulation of nonlinear airship envelop aeroelasticity by means of coupling aerodynamics and structure using an iteration method. The three-dimensional flow around the airship was studied numerically by means of SIMPLE method based on the Finite Volume Method. Two approaches, the linear method whose equilibrium equations are based on the membrane theory of thin shell and the nonlinear method which uses a nonlinear finite element method to account for the large deformation of the airship envelop, are introduced for geometrically deformation of the airship shape. A thin plate spline method is adopted as the interface of exchanging information between the fluid and structure models.

Based on this computational capability the study of the aeroelastic characters of airships is conducted. The effect of shape change of the aeroelastic model on the aerodynamic performance is detailed [Figure 1]. The contours of pressure coefficient of airships in different models are plotted [Figure 2]. The results show that aerodynamic coefficients—the drag coefficient and lift coefficient of the aeroelastic model are slightly higher than those of the rigid one. All these results will be further investigated later.

Figure 1: The coefficient of Drag C_D of the airship

Figure 2: The contour of pressure coefficient C_p of the airship

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