Study on Nonlinear Dynamic Characteristics of the Vectored Thruster AUV in Complex Sea Conditions

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Abstract: The mobility of the vectored thruster AUV in different environment is the important premise of control system design. The new type of autonomous underwater vehicle (AUV) equipped with rudders and vectored thrusters which are combined to control the course is studied. Firstly, Euler angles representation and quaternion method are applied to establish six-DOF kinematic model respectively, then Newton second law and Lagrangian approach are used to deduce the vectored thruster AUV's nonlinear dynamic equations with six degrees of freedom (DOF) respectively in complex sea conditions based on the random wave theory according to the structural and kinetic characteristics of the vectored thruster AUV in this paper. The kinematic models and dynamic models based on different theories have the same expression and conclusion, which shows that the kinematic models and dynamic models of the vectored thruster AUV are accurate. The Runge-Kutta arithmetic is used to solve the dynamic equations, which not only can simulate the motions such as cruise and hover but also can describe the vehicle's low-frequency and high-frequency motion. The results of computation show that the mobility of the vectored thruster AUV in interference-free environment and the integrated signals including low-frequency motion signal and high-frequency motion signal in environmental disturbance accord with practical situation, which not only solve the problem of especial singularities when the pitch angle $\theta = \pm 90°$ but also clears up the difficulties of computation and display of the coupled nonlinear motion equations in complex sea conditions. Moreover, the high maneuverability of the vectored thruster AUV equipped with rudders and vectored thrusters is validated, which lays a foundation for the control system design.

Key words: complex sea conditions, vectored thruster, autonomous underwater vehicle, nonlinear dynamic characteristics

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