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Science Results from Ground Based Research (4)

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ATTITUDE AND ORBIT TRACKING CONTROL SYSTEM OF DESIGNED OPERATION WITH NEUTRAL BUOYANCY FOR EXPERIMENTAL MODEL

Abstract

To ensure the working status of payloads during space missions, large numbers of ground-based experiments should be developed before launching. Thus the ground-based simulation of space microgravity environment should be considered.

With the purpose of ground-based validation of designed space operation, we develop a neutral buoyancy facility and an experimental model, which has pairs of propellers and can control the motion of the model via control commends. For the complex enviornment in the water and the difference between the actuator of experimental model and satellite, the equation of attitude dynamics based on hydrodynamics and momentum moment theorem and the equation of attitude kinematics based on the relationship of quaternion and angular velocity are derived.

In various sapce missions, rendezvous and docking(RVD) has been achieved several times in the passed space missions and has integrated process,which is quite familiar to researchers. Therefore, in this paper, the RVD process is used to be the simulation object of experimental model and three parts are discussed: 1) via the similarity principle, by considering the parameters including forces, orbit and attitude, the similarity standard between the RVD process and ground-based experiment is built to ensure the simulation of space mission as real as possible under the given experimental environment. 2) calculate the desired attitude and orbit of the experimental model using the given similarity principle and then demonstrate by simulation.3) an attitude and oribt tracking robust control system with the approach of adaptive sliding mode is presented, with a comparison between the non-coupling terms situation and a consideration of coupling terms. The closed-loop system are proved to be stable by using Lyapunov theorem of stability.

Finally, via the simulation, it is verified that by the proposed control algorithm, the inputted control commends to single unit three pairs attitude control propellers and the same account orbit control propellers can make the model tracking the desired attitude and orbit effectively with a rapid convergence to the nominal value, providing fundamental basis and prove the feasibility of the validation of space orperation by developed experimental model with neutral buoyancy.