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RESEARCH ON DYNAMIC SCALE OF FLOATING PEDESTAL MANIPULATOR SYSTEM IN GROUND MICROGRAVITY SIMULATED EXPERIMENTAL ENVIRONMENT

Abstract

Ground microgravity experiment is an important step to verify the space operation correlation technology. In this paper, we focus on the problem of motion cooperative planning of floating pedestal and manipulator in case of underactuation condition. During the research, we take a floating pedestal manipulator system (FPMS) as the object of study, utilize the magnetic-liquid hybrid suspension microgravity simulation system of the national key laboratory of aerospace flight dynamics (AFDL) to form the ground experiment environment. The FPMS is one of test models of AFDL, is a combination system, including a floating pedestal and a multi-joint manipulator, in which, the multi-joint manipulator is fastened to the floating pedestal. The floating pedestal is equipped with propellers for movement control. When considering large mass of manipulator and the interference of its movement to the pedestal, the pedestal control force required maybe larger than the maximum thrust of the propeller, then, underactuation occurs. Underactuation will cause a greater control error in the pedestal position and attitude, thus affect the movement of the end actuator of the manipulator so that it cannot move along the intended trajectory. So, it is necessary to reduce the interference and avoid underactuation. In this paper, we propose an innovative planning method for FPMS, termed dynamic scale method, in which we define a new parameter (scale factor) to introduce the interference force between pedestal and manipulator into the manipulator planning. And based on parameter transformation, we design a novel time law, with which new manipulator trajectories can be dynamically generated, meanwhile underactuation can be avoided and the end actuator of the manipulator will move along expected path. The paper mainly includes following parts: 1) building the kinetic and kinematic equation of the FPMS. 2) defining the scale factor and designing the time law of the manipulator for dynamic scale. 3) giving the process and steps of the dynamic scale to regenerate the trajectory of the manipulator. 4) verifying the feasibility of above novel method. The

results show that dynamic scale method can realize the re-planning of the manipulator trajectory, avoid the underactuation of the pedestal without any control performance loss, and make the end actuator of the manipulator along expected path to reach the target location.