IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Fluid and Materials Sciences (2)

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AERODYNAMIC DESIGN AND ANALYSIS OF MULTIROTOR ROBOT UNDER MICROGRAVITY CONDITION INSIDE SPACE STATION

Abstract

Tasks for astronauts in a space station can be complex, time-consuming, and tedious, an assistant robot could make significant differences. An artificial intelligent-based multirotor assistant robot which has the ability to interact with astronauts is proposed. The robot shall be well-qualified for works such as video recording, delivering, entertaining, and space station structural health monitoring, etc. It is designed to be spherical with diameter of 230mm and weight of approximately 2.2 kg. Mobility under microgravity condition for present robot is done by multirotor with thrust vectoring. Four ducted propellers which can be adjusted in both lateral and vertical directions are installed on the equator of the robot. Motions of translation and rotation along different axes are realized by combinations of the ducted propellers pointed to different directions. Numerical simulations are carried out for investigating the aerodynamics characteristics of the present multirotor robot. Reynolds-averaged Navier-Stokes simulation is employed for preliminary result. Instead of simulating rotating propellers which is computationally expensive, a source term methodology is employed for mimicking the operation of propellers and resulting turbulent flow. As in space station, room could be small in such closed space, fluid-structure interactions should be considered. Thrusts of the ducted propeller for multirotor robot various flight regime are calculated. Near wall of the space station, thrust of the propellers should be decreased. Wall effect will be investigated in more detail using large-eddy simulation.