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# OPTIMAL REORIENTATION OF THE HUMAN BODY UNDER MICROGRAVITY AND ITS POTENTIAL APPLICATIONS IN COMMERCIAL AND GOVERNMENTAL SPACE FLIGHT

**Abstract**

With the growth of private space travel services and the expected transition of the ISS to the private sector, a variety of people will enjoy space flight opportunities in the near future. Unlike the selected and well-trained astronauts, civilians can exhibit a significant variance in athletic performance. In addition, they may have a variety of physical characteristics, such as physical disabilities and limb deficiencies. In particular, body control under a microgravity environment is difficult for such people because sufficient training opportunities are not available before flight. Therefore, it is essential to understand the dynamics of maneuvers in order to provide a safe spaceflight experience for all people. Furthermore, understanding biomechanics in microgravity can create a new culture, such as space gymnastics competitions. It can contribute to attractive activities that cannot be experienced on Earth, enhancing physical fitness through sports, and a healthy and sustainable life in space. The author has been studying a motion planning method in which a multi-rigid body in microgravity can rapidly change its attitude (orientation of bodies) using only joint movements. This method can control attitude without any external devices, in the same way that a cat falling to the ground can instantly change its orientation by moving its body. In previous research, the author has derived approximate analytical solutions for attitude motion when joint angles are actuated along a segmented rectilinear function and proposed a method for deriving optimal attitude reorientation under constraints on joint angle limits and self-collision avoidance. Because the amount of attitude change varies nonlinearly with joint angle input, athletic and physical properties such as the range of joint actuation and limb disabilities and deficiencies may significantly change the optimal solution for this motion. In this presentation, the author will present the research results on attitude reorientation under microgravity and discuss its effective use in space flight and its potential application to space gymnastics competitions.