SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 3 (2C)

Author: Dr. Ling-bin ZENG
Shanghai Aerospace System Engineering Institute, China

Prof. Shao Jiming
China
Mr. xiao jie
China
Dr. Qiu Baogui
China
Mr. xiaotao Luo
China
Mr. Liangliang DING
Shanghai Aerospace System Engineering Institute, China

CONCEPTUAL DESIGN OF A RECONFIGURABLE ROBOT FOR THE EXPLORATION OF LUNAR LAVA TUBE

Abstract

More and more lunar lava tubes are pictured by US, JAPAN and INDIAN's lunar satellites, which are seemed as the candidate sites for future manned lunar base, because they can hide astronauts from the hazards of intensive solar radiation, numerous macro-aerolites, adhesive lunar dust, and extreme fluctuation of temperatures. A new reconfigurable hybrid arm-wheel planetary robot (RHAPR) is introduced, which has a front wheel that can be reconfigured into an arm, a back wheel whose drum is rolled by a tether that can supply electricity for the robot also, and two side leg-wheels those can spread outward and retract inward to change robot's lateral dimension. When RHAPR travels down a steep slope such as in the tube entrance, the back wheel is dragged slowly by the tether whose other end is anchored outside of the tube, the front wheel and two side wheels spread outward as much as possible to prevent the robot from overturn. The front arm-wheel and two side leg-wheels can swing to optical angles actively to keep main-body steady when RHAPR goes through uneven surfaces. Two side leg-wheels can retract inward symmetrically to pass narrow neck-shaped part of the lava tube. Two cameras mounted on two long snake-bone type mechanisms respectively can observe around conveniently with the help of LED lighters in dark tubes. RHAPR's mechanical design is described, and its front arm-wheel composed of three parts of links those are motivated only by two linear motors, can be reconfigured into a robotic arm equipping with end effectors such as cameras, grasping and drilling mechanisms. Reconfigurable mechanism's parameters are optimized to gain the largest average torques in the whole process of reconfiguration. A 50kg, 0.8m0.5m0.4m digital model of RHAPR is created and optimized by numerical simulations of statics, kinetics in the unfolding and locomotion processes, and it displays fine performances as follows: Packing efficiency is 0.35, the retracting ratio of lateral dimension is 0.6, the maximum height of surmounting obstacles is 0.3 m, the maximum degree of downing slopes is 70, the maximum degree of climbing slopes is 30, the maximum height of uplifting base is 0.3m, et al.