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EXPERIMENTAL STUDY ON A NEW TYPE OF LUNAR SUBSURFACE EXPLORER ROBOT WITH PERISTALTIC CRAWLING MECHANISM

Abstract

Unmanned deep space explorations have received a lot of attention in recent years. Some missions to land safely and explore on the surface of the moon or other planets are proposed and planned in the world. In Japan, advanced lander-rover missions have been earnestly studied for future lunar Exploration. In these missions, it is required to perform sampling, conduct in-situ analysis of geological samples and deploy devices for measurement and observation. A lot of researchers have studied and developed sample acquisition systems and driller or corer systems. Recently deep drillers or penetrating systems have been required to obtain deep data for subsurface exploration. In future lunar missions, it is needed to excavate the regolith layer, which covers the lunar surface, in depth of several meters. Some suggestions for drilling on the lunar surface have already been made. However, there are few schemes that can satisfy the requirement. This paper, to begin with, describes lunar mission scenarios and scientific requirements. A detailed surface and subsurface exploration by a mobile explorer is presented. Then this paper newly proposes a worm-typed drilling robot which is maneuverable in regolith by peristaltic crawling and the developed earth auger. A novel movement mechanism is developed referring to the bio-mechanism, in order to move forward efficiently. An earthworm moves by a locomotion mechanism called peristaltic crawling. Such a locomotion requires less space than others and allows for movement across irregular ground and inside a narrow pipe. In the proposed system, the inner wall of the body is composed of a two-layer muscle: the outside is called the circular muscle and the inside the longitudinal muscle. When the circular muscle is actuated in a radial direction, the segment is thinner, and is extended in the axial direction. When the longitudinal muscle is contracted in the axial direction, the segment gets thicker and shorter. The earthworm propagates a longitudinal wave from the front to the back of its body by contracting the muscles in each consecutive segment. So the developed mechanism can move forward in the soil. A propulsion unit using dual pantographs with a large area of an expansion plate is also developed. The drilling function is studied by analyses and some experiments. A subsurface explorer robot was newly developed and tested. The experimental results show the feasibility of the proposed robot.