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THE DESIGN OF ELECTRICAL SYSTEMS TO SUPPORT THE DEVELOPMENT OF SELF-REPLICATING ROBOTS FOR LUNAR EXPLORATION

Abstract

The exploration of planets other than Earth is likely to be dependent on unmanned rovers for the immediate future, due to the high cost of manned alternatives. Despite the financial advantage over manned exploration, rovers are still limited by the limited exploration area that can be traversed by each rover. Multiple rovers can ameliorate this problem, by splitting up in order to cover more ground and perform more tasks; however, sending multiple rovers will usually increase mission cost significantly.

The use of self-replication is responsive to this concern. With self-replicating robots, a mission begins with a single rover (or small number of rovers), which has the ability to self-replicate. The rover either brings needed materials and electronics with it, collects, processes and utilizes in-situ resources, or both. Ideally, subsequent generations of robots would be able to self-replicate, further increasing exploration capabilities. The level of robot expansion will be constrained by the availability of materials that cannot be produced locally from in-situ collected materials.

This paper proposes a design for the electrical systems of a self-replicating planetary exploration rover. In particular, it focuses on design decisions that facilitate local production and the use of in-situ materials to the greatest extent possible.

The use of in-situ resource gathering is desirable, as it can be utilized to minimize the amount of equipment necessary on takeoff, thus reducing weight and cost. However, some facets of a self-replicating rover design cannot be produced with current or near future technology. Some electrical systems fall into this category. Consequently, certain raw materials and components must be sent along with the initial rover. However, the co-printing of non-conductive structural members and conductors for electrical systems facilitates placement of electrical components (which must be brought from Earth) in protected and reclamation-accessible locations.

In conjunction with discussing the feasibility of producing some electronic system components from in-situ resources, the availability of relevant materials on the moon is also considered. The readily available lunar materials are enumerated and classified in terms of what areas they may be a suitable raw material for (electrical, mechanical, etc.). Based on this review, the feasibility of a Lunar self-replicating robot mission is evaluated and, in particular, the utility of the materials for constructing electrical system components is discussed. The paper concludes with a discussion of technical advancements that could further aid in-situ electrical system fabrication and a roadmap for future work.