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PLANETARY AUTONOMOUS CONSTRUCTION SYSTEM (P@X)

Abstract

We present a concept for a robotic construction system that can build and maintain a planetary surface human outpost and infrastructure in advance of crew arrival. The cost, risk, and complexity of launching and maintaining a pressurized living environment precludes the employment of human crews for tasks that can more efficiently be done using remote or autonomous robotic systems. On the outset, we assume that human crews do not need to be present for construction and full maintenance of a permanent planetary surface outpost. Initial delivery and placement of robotic construction equipment, site preparation, excavation, soil stabilization, paving, material handling, establishment of power / communications infrastructures, in-situ construction, and mating of pressurized modules can all be completed robotically without local human involvement, and we describe in detail how our concept will function to complete these tasks. Once the outpost has been assembled and verified operational, crew can then be launched and employed at tasks or activities that machines are less capable, or unable to accomplish.

After a brief distillation of robotic construction approaches and precedents, including terrestrial high-rise construction, large-scale 3D printing, and deployable structures, this paper will discuss pros and cons of operational prototypes intended for use on other planetary surfaces like the All-Terrain Hex-Limbed Extra-Terrestrial Explorer (ATHLETE) robotic mobility construction system. Our proposed Planetary Autonomous Construction System (PACS, or P@X) will be described in detail, including how it can overcome many of the deficiencies of ATHLETE or used in parallel with such systems.

At its core the P@X system utilizes a low-deck horizontal lander system that can deliver gantry-based constructor robots, or allow the same gantry system to off-load large habitat modules and other payloads. The gantry robots can also pick up and relocate the lander as needed. The P@X gantry will be configured to act as its own relocatable scaffolding, where two or three robots will work together to place deployable formwork over which native regolith could either be piled on top loosely, or 3D printed into panels to form an arched tunnel. Once unpressurized, radiation-shielded tunnels have been constructed, the P@X gantry system will be capable of off-loading pressurized habitat modules from newly arrived landers and docking them together inside the tunnels.

This paper shows a progress report of P@X concept development, and discusses proposed future efforts.