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PROVISIONING THE NAKED ASTRONAUT WITH BOUNTY ON MARS USING ROBOTIC SELF-REPLICATORS

Abstract

The high cost and risk associated with human Mars missions have been the primary barriers to its realisation. Much of this risk and cost can be alleviated by the emerging technology of machine self-replication. In a variation on the Mars Direct and derivative scenarios, a single self-replicating seed payload may be launched and landed on Mars prior to the launch of astronauts. The seed may be envisaged as a mobile rover mounting a variety of machine tools to acquire regolith, rock and fluids from the environment, process them and manufacture its various components and assemble them. Thus, the seed would spawn a population of universal constructing machines that would provision the astronauts with essential supplies on the Martian surface. A restricted set of raw materials from the Martian environment – consumables, iron, nickel, cobalt, tungsten, selenium, silicon and carbon – suffice to manufacture any kinematic mechanism from an array of derivative metals, ceramics and silicone plastics. Iron and its alloys form the centrepiece of this material technology. Such robotic mechanisms include powered machine tools, 3D printers, rovers, manipulators, drills, etc from which almost anything can be constructed. Such a universal constructor can by definition manufacture copies of itself thereby leveraging exponential productive capacity. No astronaut should leave Earth without a self-replicating machine – it can construct an entire Martian infrastructure as well as consumables prior to the arrival of astronauts. The key to realising such a self-replicating machine is the ability to 3D print electric motors and electronics. Indeed, the vacuum tube provides the basis for energy generation from solar concentrators (via thermionic conversion) while the electric motor provides the basis for power storage (via flywheels). We shall show our developments in 3D printing electric motors and electronics, and our Fresnel lens-based metal 3D printer that we are developing. Our hypothesis is that if we can 3D print motors and electronics, we can print almost anything. Self-replicating machines have the potential to transform human Mars exploration in terms of both cost and risk.