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STEPS TOWARDS 3D-PRINTABLE SPACECRAFT AS A BYPRODUCT OF SELF-REPLICATION TECHNOLOGY

Abstract

I have embarked on an investigation into the feasibility and implementation of 3D-printable spacecraft. On extraterrestrial environments, functional simplicity and ease of manufacture would permit the use of in-situ resources and the prospect of self-replication using the 3D printer as a universal constructor. Recently, most interest in in-situ resource utilisation has been on consumables such as propellant and oxidiser for propulsion to support human missions. My starting point is the RepRap 3D printer which can manufacture its own plastic parts. I have focussed on the most challenging aspects that are often relegated to beyond the capacity of 3D printing, namely, actuators, electronics and computing. This covers many aspects of spacecraft design including mechanisms, control systems, power distribution avionics, computer-based avionics and communications avionics. My group has been prototyping a shape memory alloy actuated motor design which demonstrates the feasibility of 3D-printable motors for mechanisms. The motor also provides the basis of power storage through flywheels. This actuator work is ongoing and is presented in detail. The next stage to consider is electronics initially through motor controllers. Semiconductor transistor foundries would be prohibitive so vacuum tube technology offers a potentially printable approach to electronics. The first implementation is a simple PID analogue controller circuit for the motor. Simple feedback sensors are implemented through rotary potentiometers. I have adopted hardware neural networks as the computational medium of choice – my group has investigated offline genetic algorithm training of neural nets for eventual hardware implementation based on op-amps. Further sensory capabilities are enabled through quartz (as the basis for both displacement sensors and oscillators in radiofrequency circuits) and selenium (as the basis for vision sensing and Reichardt detectors). Furthermore, the first semiconductor junction solar cells were constructed from selenium and gold film though offering only 1