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CROWDSOURCING SPACE EXPLORATION WITH SPACECRAFT-ON-DEMAND

Abstract

Conventional methodologies do not scale to support the development of more than the few dozen spacecraft missions launched every year. We propose a new approach: a crowdsourced integrated system permitting the rapid development, deployment and operation of millions of small missions by explorers ranging from expert scientists and engineers to non-expert members of the public. Crowdsourcing, as demonstrated by Galaxy Zoo and StarDust@Home, is a powerful method of outsourcing tasks to a large amateur community.

Multiple small spacecraft result in economies of scale, redundancy and agility as recognized by projects such as NPSCuL and QB50. Community participation in space exploration allows orders of magnitude more missions and generates excitement about space, science, and technology in classrooms and living rooms worldwide.

Our web based system will allow explorers to select mission goals, constraints, and preferences. It will analyze these choices and suggest mission profiles and spacecraft designs, allowing explorers to trade-off design time, cost, capability, and performance. Interaction ranges from completely automated o extremely hands-on. It draws upon a library (designed and rated by explorers for utility, reputation, and quality) of open source, often reconfigurable, spacecraft components, subsystems, and mission architectures. Proven existing tools model, simulate and optimize the various subsystems. A concurrent design philosophy allows selection of appropriate spacecraft and mission configurations by iterating between subsystem optima while capturing whole system interactions.

To address the problem of building and deploying large numbers of small satellites, we propose producing and deploying spacecraft with Prepositioned Orbiting 3D Printers (POPs) such as our 2U CubeLab POP under development. Initial POPs (derived from existing extrusion 3D printers, wire-wrapping and pick-and-place machines) build spacecraft using replaceable ICES cartridges containing extrudable Insulator, Conducting wire, battery/solar cell Energy modules and Semiconductor modules borrowed from existing CubeSat and myPocketQub projects.

We describe architecture and prototypes of automated systems for operating the spacecraft, built for use by anyone. Tracking, telemetry, control, and payload data is transferred by communication networks consisting of spacecraft and ground stations, and allow reconfigurable parts such as FPGAs, memory metals, and software to be updated in-flight, permitting many explorers to share the same spacecraft for different missions. Social and legal structures necessary to manage such spacecraft are also addressed.

Crowdsourced robotic space exploration could dramatically alter the pace and economics of space research. A Spacecraft-on-Demand system demonstrating scalable production of spacecraft on-orbit is expected to be operational in 2012.