MODULAR SPACECRAFT WITH INTEGRATED STRUCTURAL ELECTRODYNAMIC PROPULSION

Nestor Voronka
Tethers Unlimited
Bothell, WA

NASA's Vision of Exploration relies on numerous systems of systems to support a return of robotic and human explorers to the Moon in preparation for human exploration of Mars. Virtually all architectures considered to date require a very large total mass of material to be either launched from Earth, or obtained from the moon or asteroids and made available for structural, propulsion, shielding or other consumable needs. To move this material in near-Earth and cislunar space using traditional propulsion systems, the propellant masses for these operations represent a large fraction of the total required launch mass.

We propose to develop a multifunctional propulsion-and-structure system that utilizes electrodynamic forces generated by current-carrying booms to generate thrust without propellant expenditure. This technique will utilize methods conceptually similar to electrodynamic tethers; however, our approach provides a capability for generating thrust in any direction as well as for providing torques for spacecraft attitude control. Our approach will utilize several relatively short rigid booms with integrated conductors capable of carrying large currents, as well as components to enable electrical plasma contacts at the ends of each boom. Six of these booms will be connected to a host spacecraft along orthogonal axes, enabling the system to exert control of all six degrees of freedom of its motion in space. This propellantless propulsion and attitude control structure will facilitate self-assembly of large space systems, and enable propulsion of an assembled system during and after such assembly. By making the system modular, whereby the control nodes and booms are modular and interconnectable, these elements form an innovative Tinkertoy®-like family of components from which larger scale systems can be assembled and reassembled. These modular multi-function elements can be self-assembled into resource depots, structures to support ISRU-derived shielding materials, and larger space tugs that can support NASA's Vision of Exploration.