

# ABSTRACT

A new concept for generating charge at a small voltage using nano conductive materials is proposed for the realization of Lorentz force torqued satellite. This reduces the charge density considerably, thereby lowering the required voltage to two digits. A comprehensive new mathematical formulation of the Lorentz force and torque acting on the satellite due to the distributed charge is also rigorously investigated. It is shown that, due to the ill conditioned matrices involved in the torque and force equation, eliminating the Lorentz force is not possible under any charge distribution scheme. Getting a solution to differential charges on the opposite shells is not possible for any practical problem. Moreover, the Lorentz torqued system loses its average three-axes controllability at extremely high angular velocity for different magnitude but opposite sign charges on the opposite shells. It is also shown that when the charge moment is constrained to fall in the plane of velocity and the magnetic field vectors, then two axes of control can only be achieved. To overcome these problems a combined Lorentz force and magnetic torquers satellite actuation is proposed and rigorously investigated. It is shown that such a system will be instantaneously controllable along the three orthogonal axes. A PD control is implemented for this system. It is shown that such a system is globally stable and locally exponentially stable. In addition, a finite-time sliding control and a fixed time adaptive fault tolerant sliding control is formulated and implemented for the combined system. Stability of the combined torquers system is proved for both the sliding controls. It is proved that both the sliding controls make the system finite time stable. It is shown that the performance of the fixed time sliding control is superior to the finite-time sliding control. Moreover, the fixed time control works in the presence of fault but with small deterioration in attitude convergence.