Novel Coulomb Staged-Docking using Predefined-Time Sliding Mode Control

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- The use of electrostatic actuation for formation flying and on-orbit proximity operations has been gaining attention in the Aerospace community in recent years. With its high specific impulse and low plume impingement, this method of propulsion provides a sustainable and efficient way for proximity maneuvers.

- Previous attempts to model charged interactions between spacecraft considered linearized motion dynamics, which failed to provide an accurate trajectory description and disregarded non-circular orbits. These nonlinearities in motion must be addressed as precise control of Voltage is required for autonomous rendezvous and docking.

- This paper introduces a novel method of spacecraft-docking that utilizes Coulomb control with staged bipolar electrospray thrusters in binary switching mode.

- The system consists of two spacecraft: chaser and target in GEO orbit, which aims to first rendezvous and then dock with each other. Both spacecraft are capable of controlled charging. The target has hybrid bipolar

electrospray thrusters with binary switching mode: the polarity of ejected ions can be changed as per requirement.

- The use of electrospray thrusters imparts a residual voltage to the target and is used to aid Coulomb control through binary switching, thus reducing the charging control effort.
- System's dynamics is modeled using Gauss variational equation for modified equinoctial elements. This particular choice of orbital element set avoids singularities while integrating for trajectory propagation.
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