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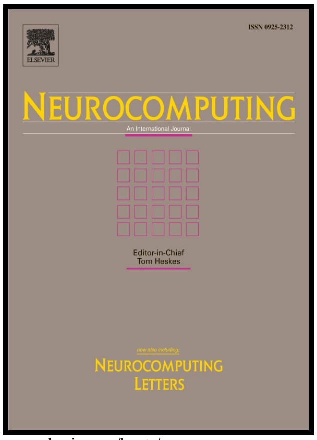

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Neural network-based adaptive second order sliding mode control of Lorentz-augmented spacecraft formation

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Abstract

The Lorentz force acting on an electrostatically charged spacecraft provides a new means of propulsion for orbital maneuvers such as Lorentz-augmented spacecraft formation flying. Modeling the Earth's magnetic field as a tilted dipole corotating with Earth, a nonlinear dynamical model that describes the orbital motion of a Lorentz spacecraft about an arbitrary elliptic orbit is developed. Then, the optimal open-loop control trajectories of formation establishment are solved by the pseudospectral method. To guarantee trajectory tracking in the presence of external perturbations and system uncertainties, a closed-loop neural network-based adaptive second order fast terminal sliding mode controller is designed using state feedback, which simultaneously solves the singularity and chattering problems that generally exist in conventional terminal sliding mode. Neural networks are employed to approximate the unknown nonlinearities in the system dynamics. Meanwhile, to ensure closed-loop tracking control without velocity measurements, an output feedback controller is also proposed with an observer introduced to capture the velocity signals. The overall stabilities for both control schemes are proved by a Lyapunov-based method. Numerical simulations are presented to verify the performance of the proposed controllers. Furthermore, the controllers could be applied to other Lorentz-augmented