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MATLAB simulation of a pure B-dot algorithm for CubeSat-like nadir pointing in orbit

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Abstract

This paper presents a MATLAB simulation framework developed to evaluate whether a pure B-dot magnetic control law can provide nadir pointing for a CubeSat-like nanosatellite in the local-vertical/local-horizontal (LVLH) frame and maintain that orientation over an orbital pass. The model includes rigid-body rotational dynamics, orbital motion, magnetic actuation, gravity-gradient torque, and a geomagnetic field representation appropriate for low Earth orbit. The obtained results show that the controller is effective as a detumbling law: the transverse angular-rate components are reduced and the commanded magnetic dipole remains bounded by the actuator limits. However, pure B-dot control does not provide complete nadir locking. A persistent residual rotation about the LVLH z-axis remains, which keeps the total pointing error high. In the baseline case, the RMS nadir-pointing error over the last orbit is 104.05 deg. Additional sweeps over initial angular-rate magnitude and orbit parameters show almost no improvement, indicating that the limitation is structural rather than caused by a specific initial condition. The study therefore confirms that pure B-dot control is suitable for rate damping and coarse acquisition, but not for precise nadir pointing without an additional attitude-holding law.

***Keywords**: cubesat; magnetorquer; matlab simulation; nadir pointing*

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