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Research Article

FORMATION-KEEPING OF UNCERTAIN SATELLITES USING NONLINEAR DAMPING CONTROL†

T. WANICHANON[1,*]
F.E. UDWADIA[2]
H. CHO[3]
[1] Lecturer, Department of Mechanical Engineering, Mahidol University, 25/25 Puttamonthon, Nakorn Pathom 73170. Thailand
[2] Professor of Aerospace and Mechanical Engineering, Civil Engineering, Mathematics, and Information and Operations Management, 430K Olin Hall, University of Southern California, Los Angeles, CA 90089-1453
[3] Samsung Techwin Co., Ltd. Power Systems Division, 701 Sampyeong-dong, Bundang-gu, Seongnam-si, Gyeonggi-do 463-400, Republic of Korea

ABSTRACT:
A formation-keeping control methodology is proposed that includes both attitude and orbital control requirements in the presence of model uncertainties. The approach develops the requisite control in a two-step process. First, a nominal system model that provides our best assessment of the real-life uncertain system is defined, and a nonlinear controller that satisfies the required attitude and orbital requirements of this nominal system is developed. The controller allows the nonlinear nominal system to exactly track the desired attitude and orbital requirements. Since this closed-form controller assumes that the model of the physical system—the nominal system—has no errors or uncertainties, in the second step an additional additive controller that compensates for model uncertainties is developed. The desired trajectory of the nominal system is used as the tracking signal, and a controller based on a generalization of the concept of a nonlinear damping is developed. The resulting closed-form control causes the desired attitude and orbital requirements of the nominal system to be met in the presence of unknown, but bounded, model uncertainties.

Keywords: *Satellite Formation Keeping; Orbital Control; Attitude Control; Model Uncertainties; Nonlinear Damping Control*

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1. INTRODUCTION

The use of small multiple satellites flying in formation holds out the potential for reducing total mission costs, performing certain missions more flexibly and efficiently, and making possible advanced applications such as space interferometry and high resolution imaging [1]. This paper addresses the formation-keeping problem in the presence of model uncertainties. We consider a satellite formation in which a set of follower satellites follows, in a desired manner, a leader satellite. The leader satellite may be a real or fictitious satellite located at a specified location relative to the different follower satellites that constitute the formation. Our aim is to develop a control methodology so that each follower satellite in the formation achieves a desired attitude *and* a desired formation configuration in the presence of uncertainties. The relative trajectories of the follower satellites that comprise the formation (with respect to the leader satellite) may be static in time or they may be required to change dynamically in some prescribed, desired manner.

Since formation-keeping is important to successfully achieve a mission goal by regulating the orbits and attitudes of the satellites that fly in a cluster, numerous researchers have been attracted to this problem.

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* Corresponding author: T. Wanichanon
E-mail address: thanapat.wan@mahidol.ac.th