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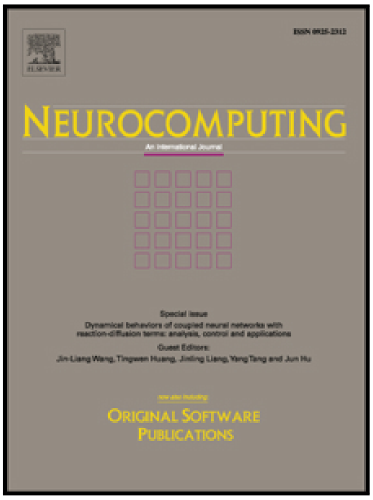

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Event-triggered neuroadaptive control for postcapture spacecraft with ultralow-frequency actuator updates

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Abstract

This paper investigates an event-triggered neuroadaptive control approach for postcapture flexible spacecraft with guaranteed prespecified tracking performance in the presence of unknown inertial properties, actuator constraints, and external space perturbations. By employing the minimum-learning parameter technique into the neural proportional integral-like controller, only two adaptive parameters are required to update online, which completely avoids the tedious inertial parameter identifications and dramatically reduces the complexity of controller in the meanwhile. Compared with existing works, the primary advantage of the proposed attitude control approach is that the actuator updates are determined by the prescribed event-based conditions in an aperiodic way rather than a periodic one, which greatly reduces the actuator updates. Finally, two groups of illustrative examples are organized to validate the effectiveness of the proposed approach in terms of attitude stabilization and tracking for the postcapture flexible spacecraft.

Keywords: Postcapture spacecraft; Attitude control; Event-triggered control; Prescribed performance.

1. Introduction

The past few decades have witnessed the burgeoning development in on-orbit servicing technologies due to their potential military and commercial applications such as military reconnaissance, debris removal, deep space exploration and astronavigation, to name a few [1, 2, 3, 4, 5]. Among them, the robotic manipulator mounted on service spacecraft as a vital tool is widely used to capture the cooperative or non-cooperative space targets. Consequently, many research issues spring up such as parameter identification for the space robotic systems [6]. In [7], a constrained predictive control scheme was developed to capture a free-floating and spinning satellite based on a linearized dynamic model via a deployable manipulator. This control method requires accurate model information and costs large computational resources to support its iterative optimization, which is not easily achievable in practice [8].

In the future space capture missions, most of the on-orbit targets are non-cooperative, which makes it very challenging to accomplish the corresponding tasks including the pre-capture, capturing and postcapture phases [2, 6, 9]. In this work, we mainly focus on the control system design in postcapture phase for the service spacecraft with an unknown captured object. To address this problem, Bandyopadhyay *et al.* developed a nonlinear adaptive control scheme for the postcapture spacecraft with guaranteed exponential convergence in the presence of uncertain dynamics and external disturbance [9]. Chu *et al.* used the contact information to obtain the detailed information of the unknown space target with a space manipulator, which is beneficial to the design of the associated attitude controller [10]. Huang *et al.* devised a modified dynamic inverse control scheme based on the estimation for the inertial properties of the postcapture spacecraft [11]. Owing to the mounted flexible appendages like solar panels, vibration of flexible structures brings unexpected effects on the system stability of the spacecraft. To enhance the robustness of the control system, sliding mode control technique was adopted in the relevant attitude controller deisgn like in [12, 13, 14, 15]. Although effective, it cannot be directly extended to the postcapture flexible spacecraft where unknown inertial properties are encountered. Different from the direct identification for the inertial properties, in light

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