Global Attitude Stabilization of a Rigid Body on SO(3) via Observer-based Hybrid Feedback Under Constraints

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Research Article

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Abstract

This paper studies the global stabilization of a rigid body attitude, a task that is subject to topological obstacles. These

obstructions preclude the existence of a globally stable equilibrium point. Consequently, the rigid body attitude cannot

be globally stabilized by continuous feedback control laws. In order to resolve this challenge, this paper presents an

observer-based hybrid feedback control law. Thereafter, in order to derive the proposed feedback law, a new kind of

synergistic potential functions is presented which induces a gradient vector eld to globally stabilize a given set. Moreover, the gradient of the proposed synergistic potential functions is utilized to derive a hybrid angular velocity

observer. The outputs of the proposed observer are employed to produce the necessary damping from the noisy measurements of the attitude. Furthermore, this paper considers two types of constraints: angular velocity constraints, and input torque constraints. Afterward, these constraints are formulated in terms of the Linear Matrix Inequalities (LMI) optimization problem to perform constraints satisfaction at all times. Moreover, this paper introduces a novel hybrid quantizer to deal with the problem of the low-price wireless network. This paper analyzes the global asymptotic stability of the reference set via the Lyapunov's method. Finally, a comparative study in simulations is provided to assess the performance of the proposed control technique.

Full Text

This preprint is available for download as a PDF.

Figures

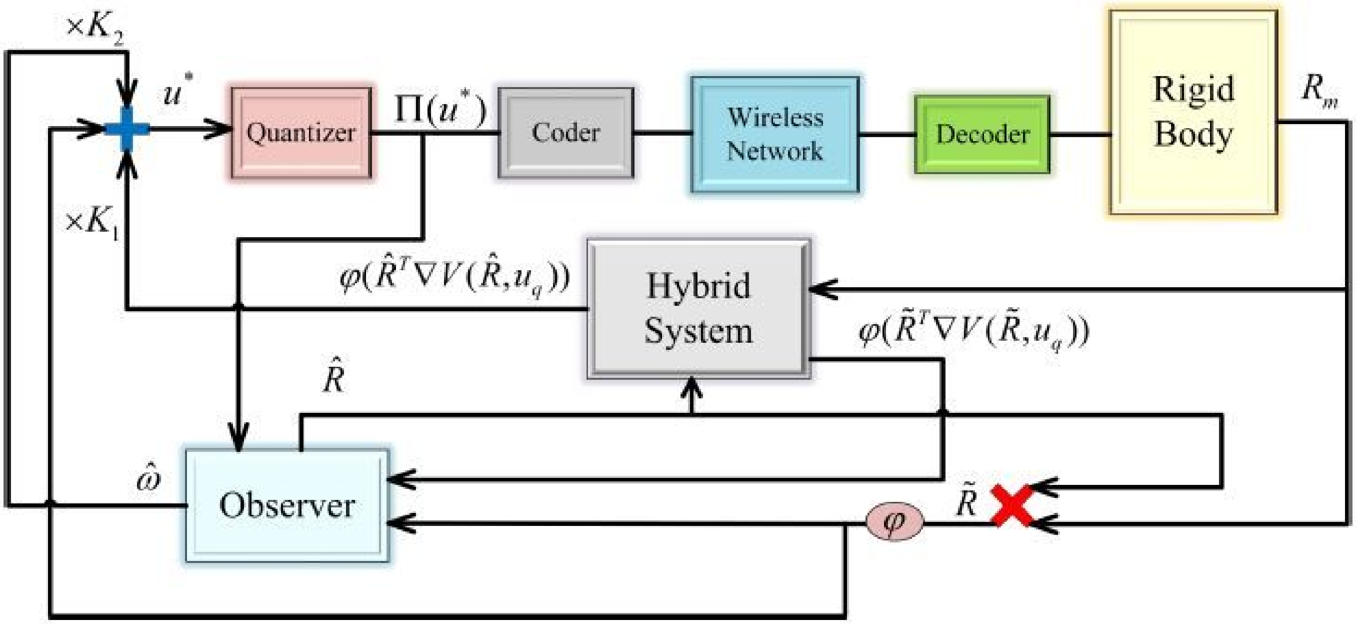

Figure 1

Block diagram of the proposed hybrid feedback law.

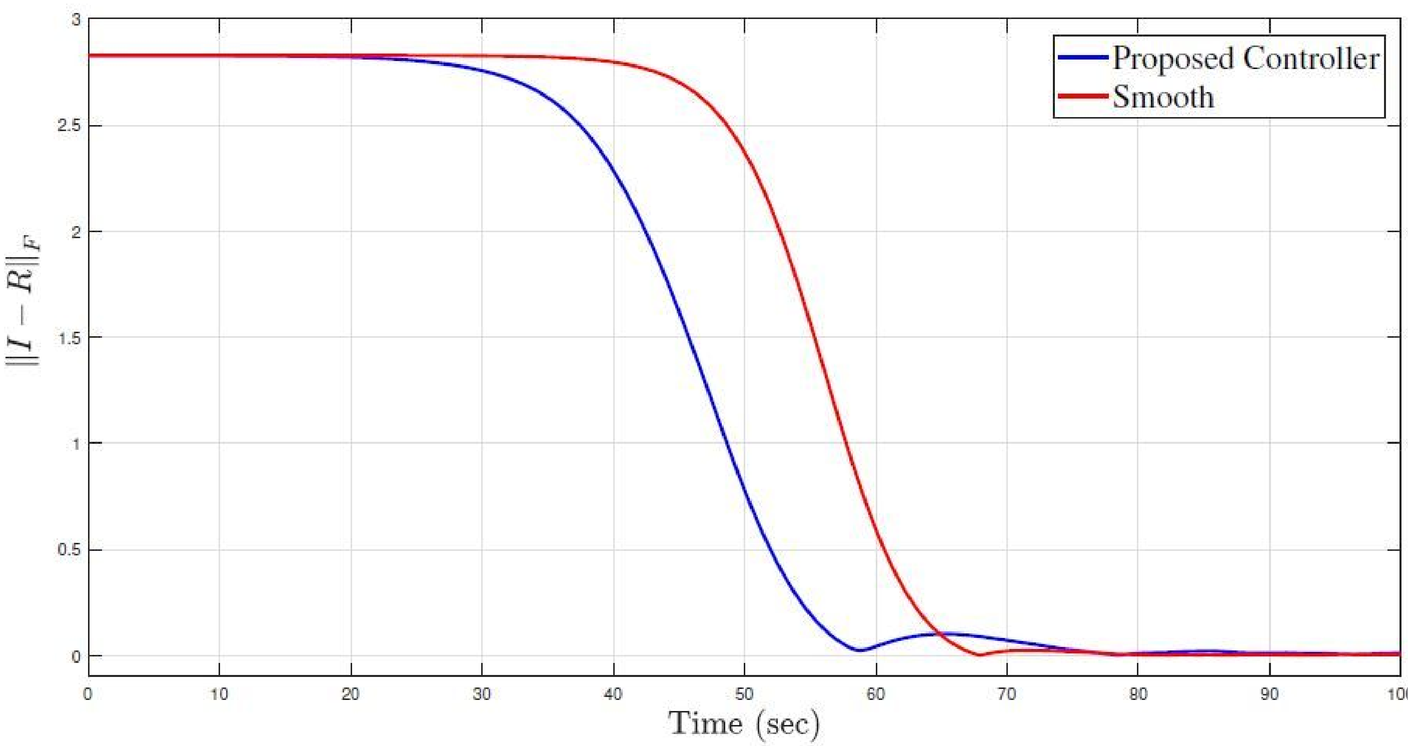

Figure 2

Attitude tracking errors versus time in the first experiment.

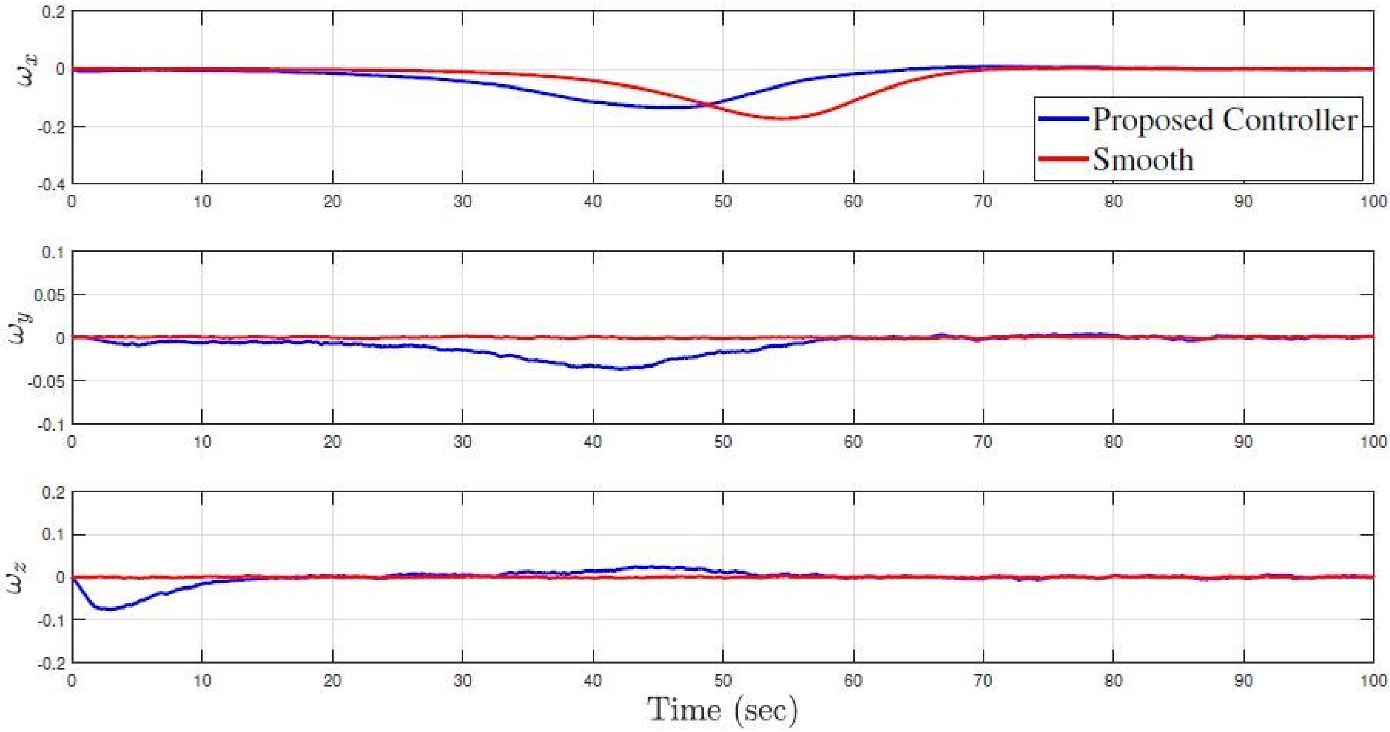

Figure 3

Response of the angular velocities in the first experiment.

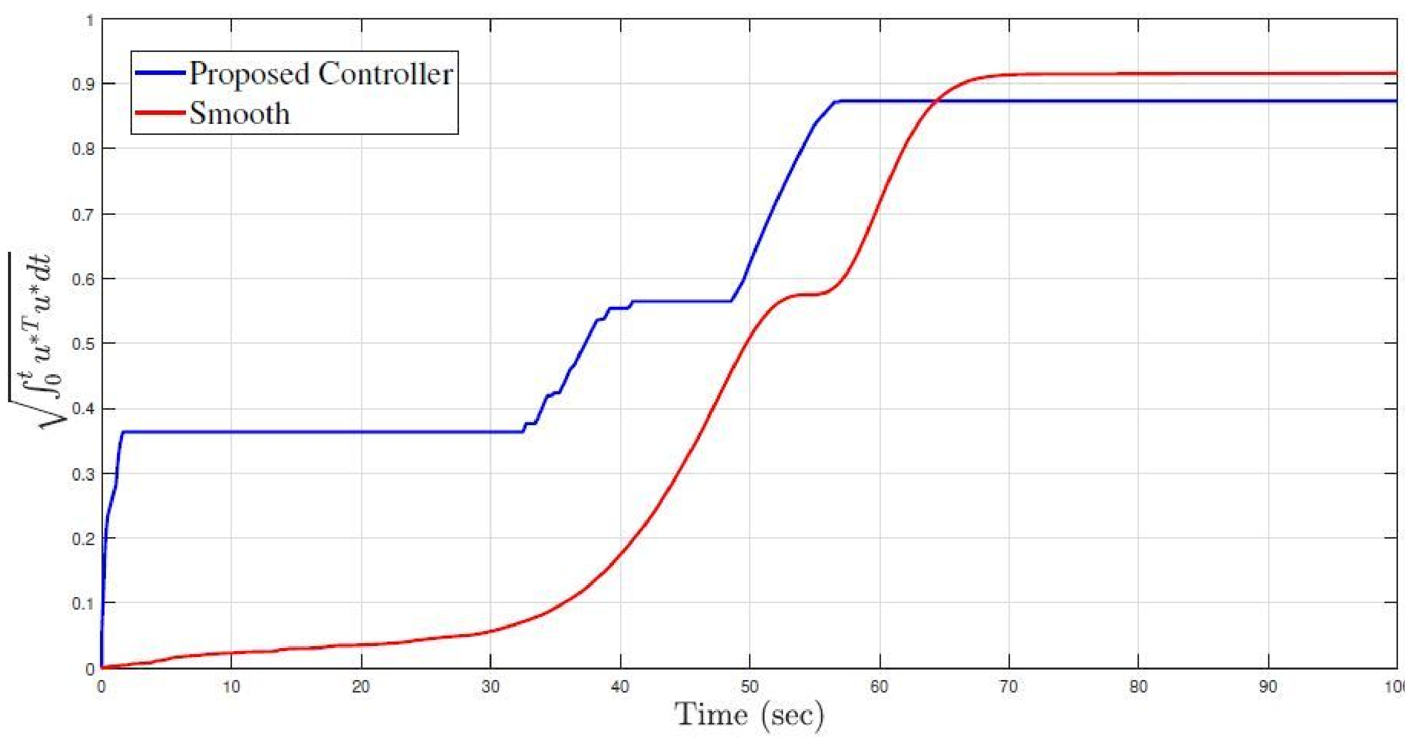

Figure 4

Energy consumption versus time in the first experiment.

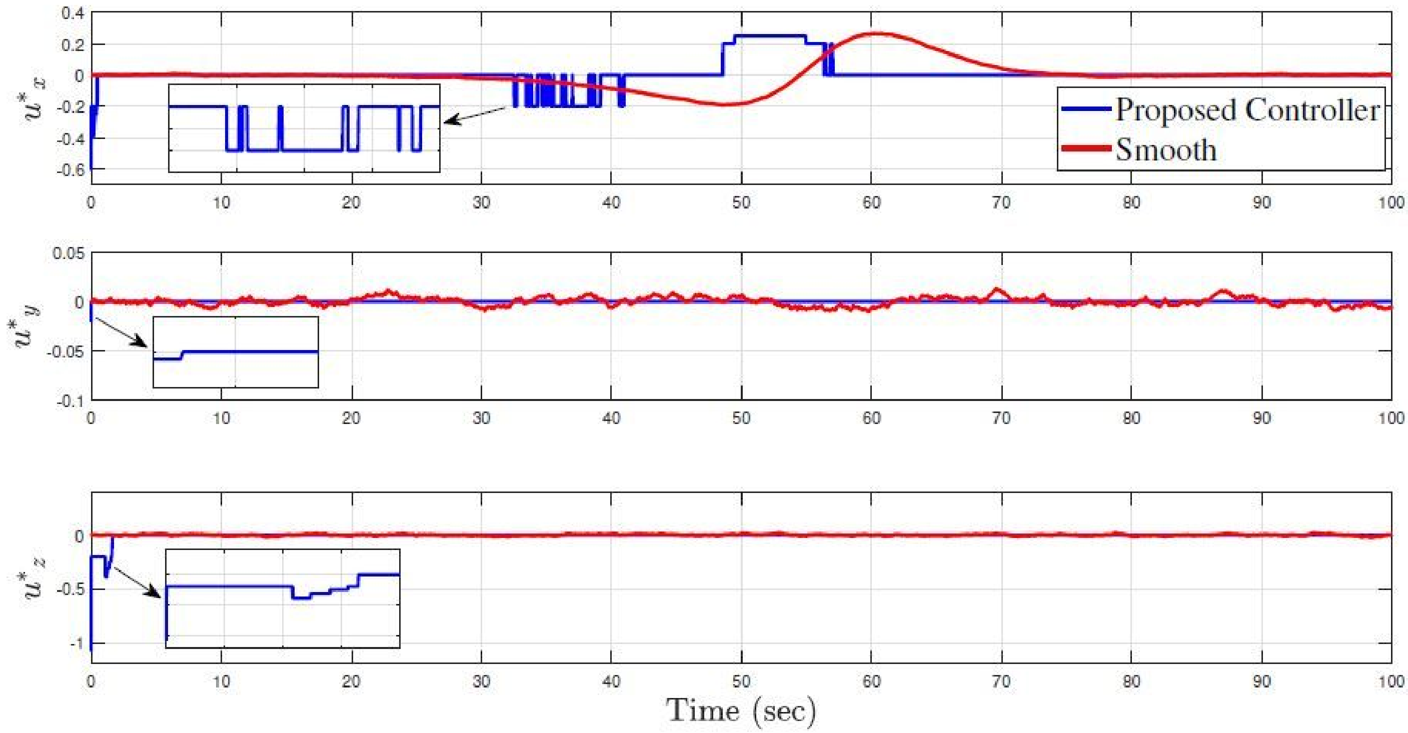

Figure 5

Response of the control signals in the first experiment.

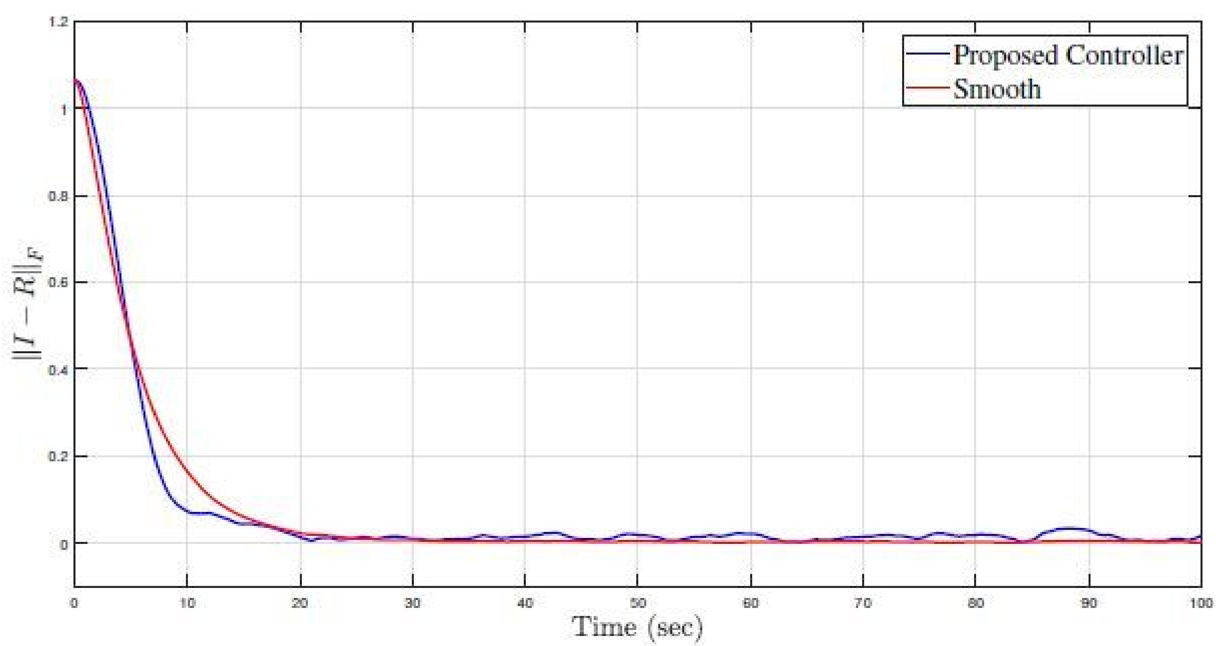

Figure 6

Attitude tracking errors versus time in the second experiment.

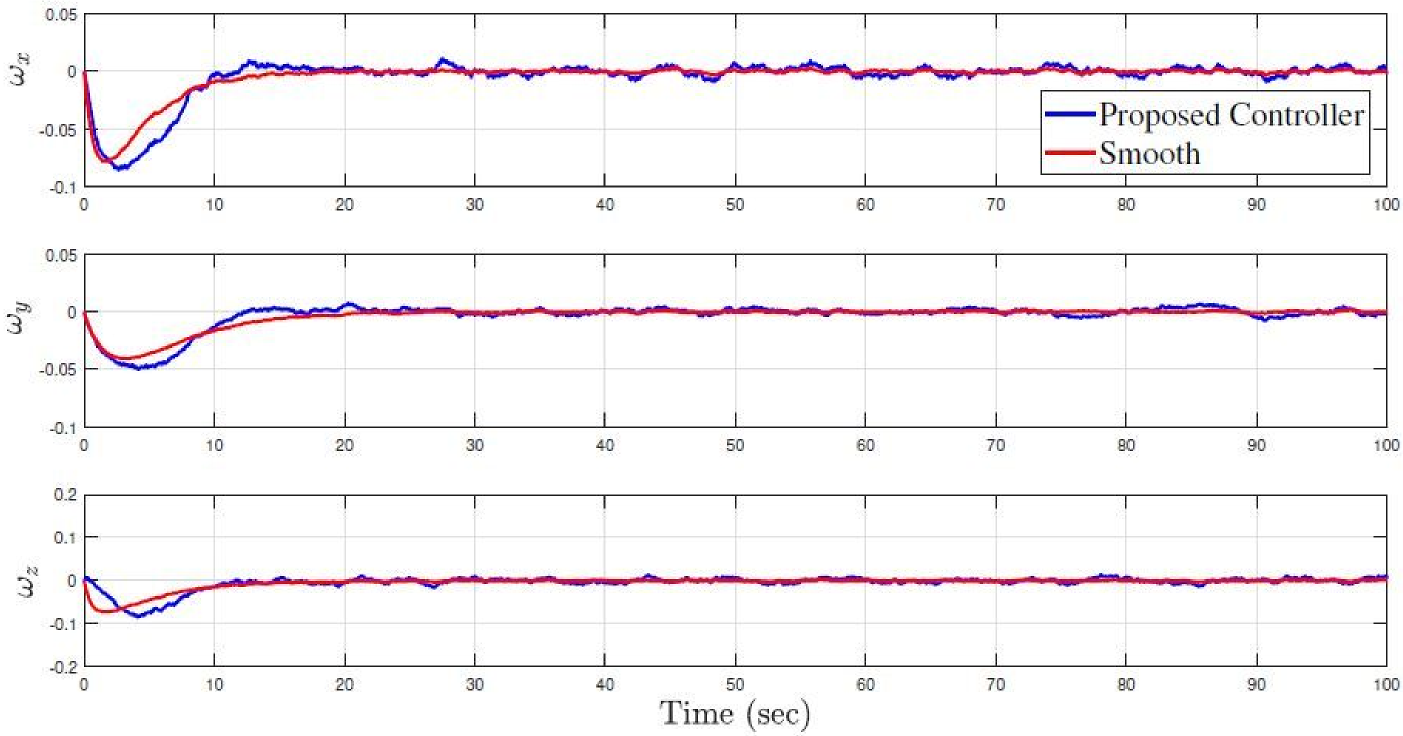

Figure 7

Response of the angular velocities in the second experiment.

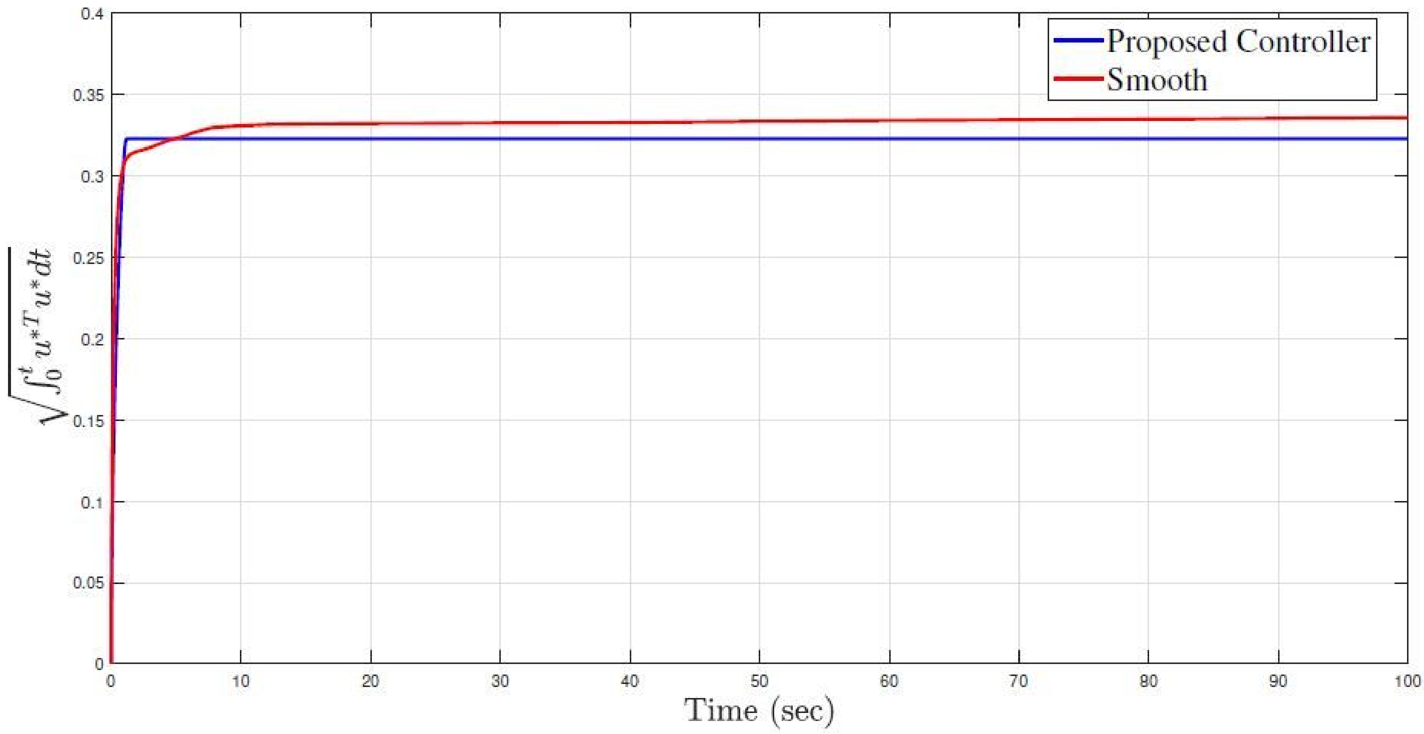

Figure 8

Energy consumption versus time in the second experiment.

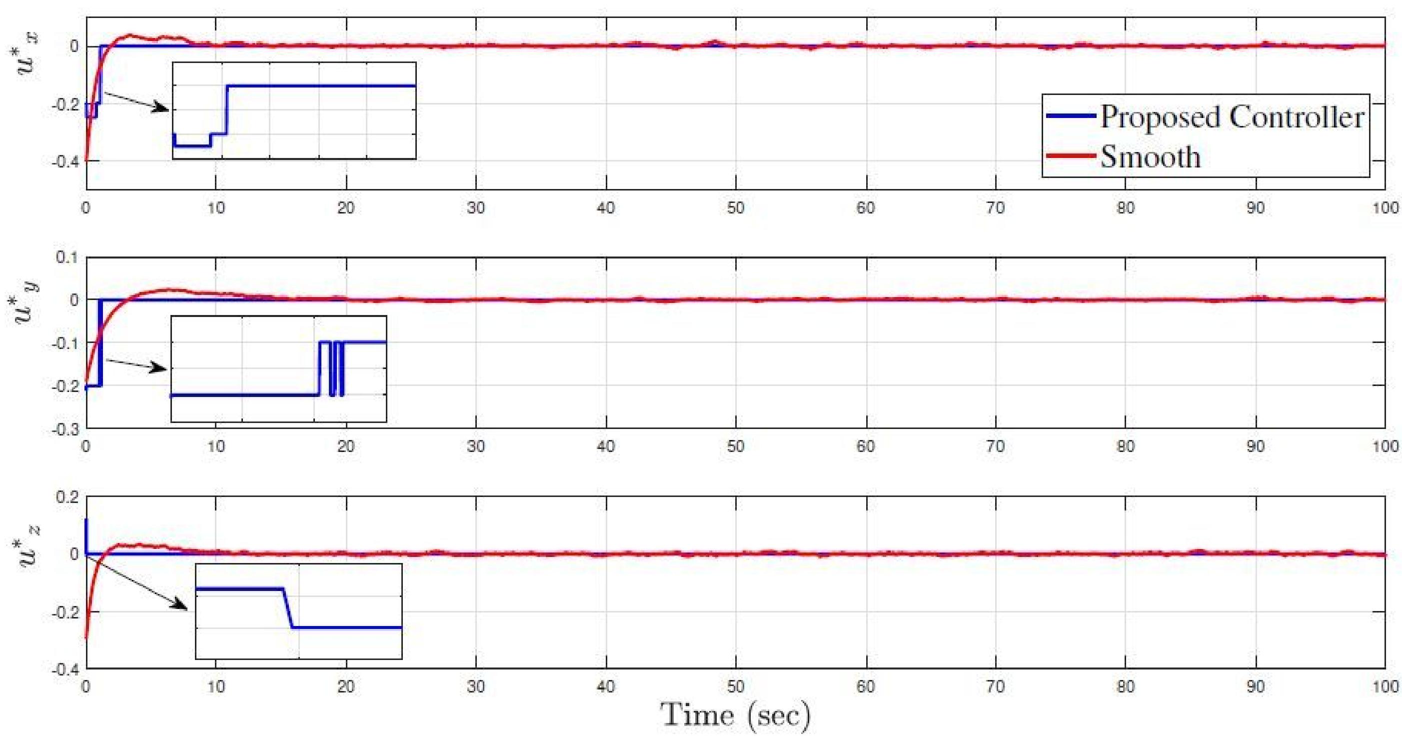

Figure 9

Response of the control signals in the second experiment.