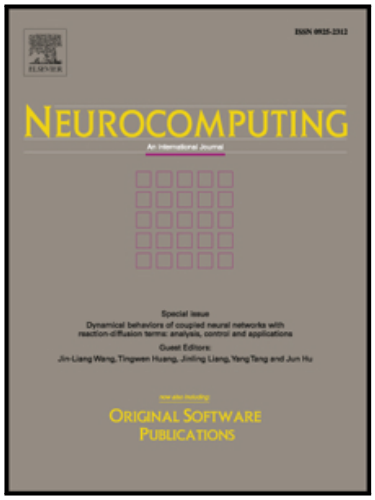
Communicated by Dr. Ma Lifeng Ma

# Accepted Manuscript




Sliding mode control for networked systems with randomly varying nonlinearities and stochastic communication delays under uncertain occurrence probabilities

Panpan Zhang, Jun Hu, Hongjian Liu, Changlu Zhang

PII: S0925-2312(18)30993-7
DOI: https://doi.org/10.1016/j.neucom.2018.08.043
Reference: NEUCOM 19891

To appear in: *Neurocomputing*

Received date: 28 May 2018
Revised date: 16 August 2018
Accepted date: 20 August 2018

Please cite this article as: Panpan Zhang, Jun Hu, Hongjian Liu, Changlu Zhang, Sliding mode control for networked systems with randomly varying nonlinearities and stochastic communication delays under uncertain occurrence probabilities, *Neurocomputing* (2018), doi: https://doi.org/10.1016/j.neucom.2018.08.043

# Sliding mode control for networked systems with randomly varying nonlinearities and stochastic communication delays under uncertain occurrence probabilities

Panpan Zhang [a], Jun Hu [a,b,*], Hongjian Liu [c], Changlu Zhang [a]

[a] *Department of Mathematics, Harbin University of Science and Technology, Harbin 150080, China*

[b] *School of Engineering, University of South Wales, Pontypridd CF37 1DL, UK*

[c] *School of Mathematics and Physics, Anhui Polytechnic University, Wuhu 241000, China*

**Abstract**

In this paper, we aim to propose the robust sliding mode control (SMC) scheme for discrete networked systems subject to randomly occurring uncertainty (ROU), randomly varying nonlinearities (RVNs) and multiple stochastic communication delays (MSCDs). Here, a series of mutually independent Bernoulli distributed random variables is introduced to model the phenomena of the ROU, RVNs and MSCDs, where the occurrence probabilities of above phenomena are allowed to be uncertain. For the addressed systems, an SMC strategy is given such that, for above network-induced phenomena, the stability of the resulted sliding motion can be guaranteed by presenting a new delay-dependent sufficient criterion via the delay-fractioning method. Moreover, the discrete sliding mode controller is synthesized such that the state trajectories of the system are driven onto a neighborhood of the specified sliding surface and remained thereafter, i.e., the reachability condition in discrete-time setting is verified. Finally, the usefulness of the proposed SMC method is illustrated by utilizing a numerical example.

*Key words:* Sliding mode control; Networked systems; Randomly varying nonlinearities; Multiple stochastic communication delays; Uncertain occurrence probabilities.

## 1 Introduction

Over the past several decades, as an effective control strategy, the sliding mode control (SMC) technique has been extensively applied in many practical domains due to its superiorities, such as the robustness against parametric uncertainties and unknown disturbances on the prescribed sliding surface. Accordingly, the application problems of SMC have gained certain research attention, such as in dynamical networks, robotics and spacecraft [1–4]. As such, many important SMC methods have been developed for various systems according to their structural characteristics, see e.g. [5,6]. For example, the SMC problem has been studied in [5] for uncertain delayed multi-agent systems with external disturbances. It is worthy of noting that, since most control algorithms have been implemented digitally in modern industrial fields, the discrete-time SMC design of control systems has increasingly become prevalent [7–11]. For example, the quasi-sliding mode idea has been proposed in [9] and the SMC problems for complex systems based on the quasi-sliding mode have been extensively addressed. For instance, based on the method in [9], the reaching law