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Corrigendum

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Corrigendum to: Dual-stage adaptive finite-time modified function projective multi-lag combined synchronization for multiple uncertain chaotic systems

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We add the section “Introduction” to the original article found at https://doi.org/10.1515/math-2017-0087 as follows.

1 Introduction

Due to its potential applications for secure communication, engineering science, biological systems and other fields, the synchronization of chaotic systems has been an active research object. The main idea of synchronization is to design an appropriate controller to make the state of response system track the state of the drive system asymptotically [1-10]. The response system and the drive system may have identical or different structures.

Most of the previous researches were primarily concerned with the asymptotic stability or exponential stability of the synchronization error system. From a practical point of view, particular in engineering fields, optimizing the synchronization time is more important than achieving asymptotic synchronization. This implies the optimality in settling time [11]. To realize the fast synchronization, the finite-time control technique which can drive the controlled system to its target within finite time has been formulated [12]. Later, in combination with sliding mode technique, the terminal sliding mode control was put forward to deal with the finite-time control issue [13]. What is more, such a technique could guarantee finite-time convergence, strong robustness and better disturbance rejection properties once the terminal sliding mode is reached [14]. This method has been further extended to the research of multi-input and multi-output cases. To overcome the problem of the existence of the singularity when conventional terminal sliding mode control was applied in actual cases, a new nonsingular terminal sliding surface has been designed and applied into the chaotic synchronization [15,16].

It is a pity that all the finite-time synchronization methods mentioned above have been limited to complete synchronization. So far, many types of complex synchronization have been proposed in dynamical systems, such as complete synchronization (CS) [17,18], anti synchronization (AS) [19], lag synchronization [20], intermittent lag synchronization [21], phase synchronization [22], generalized synchronization [23], intermittent generalized

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synchronization [24], projective synchronization (PS) [25,26], modified projective synchronization (MPS) [27], function projective synchronization (FPS) [28], time scale synchronization [29] and so on. Recently, a more general form of FPS called modified function projective synchronization (MFPS) [30-32] in which the drive system and the response system are synchronized up to a desired scaling function matrix has attracted the researchers attention for its higher security in secure communication. Therefore, the research on MFPS is more valuable in practice. What is more, considering that time-delays exist widely in engineering, more recently a general method called modified function projective lag synchronization (MFPLS) in chaotic systems has been developed [33-36].

However, all of the synchronization methods above were involved in one drive system and one response system. To further improve the security when the synchronization technique is applied in the secure communication, R.Luo proposed the combination synchronization which contains two drive systems and one response system [38,39].

Motivated by the discussion above, in this article we defined a new synchronization method – the modified function projective multi-lag combined synchronization. Applying the variable structure control technique, we discuss the finite-time modified function projective multiple lag combined synchronization for a series of different chaotic systems with fully unknown parameters and unknown bounds on external disturbances. Firstly, we establish a new nonsingular terminal sliding surface which is finite-time convergence for the multi-input and multi-output system. Afterwards, on the basic of Lyapunov stability theory and the finite-time control technique, the suitable controller is designed to realize the occurrence of the sliding motion within a finite time, and the appropriate adaptive laws are given to estimate the unknown parameters accurately. At the end of the paper, a simulation is put forward to demonstrate the feasibility and correctness of the advanced scheme.

Compared with the existing literature, this paper has the following advantages. Firstly, the modified function projective multi-lag combined synchronization (MFPMLCS) is more general and it covers almost all of the existing synchronization methods. Secondly, both the fully unknown parameter and bound-unknown disturbance are taken into consideration. In addition, the terminal sliding surface given in this paper is more advantageous.

References can be found in the original article:
https://www.degruyter.com/view/j/math.2017.15.issue-1/math-2017-0087/math-2017-0087.xml