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AN OPTIMIZED PROJECTIVE SYNCHRONIZATION BASED ON ASMC FOR CHAOTIC FRACTIONAL-ORDER COULLET SYSTEM

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Abstract. In this paper, behavior of fractional Coullet systems will be studied. Main objective of this work is to investigate the Chaotic behavior on fractional-order Coullet system and also the controllability. It has been shown that this problem may take place on synchronization of two master and slave systems with the same or different fractional-order. The proposed Projective synchronization method is based on active sliding mode control (ASCM). It has been developed to synchronize two chaotic systems with similar or partially different attractor. As a result of using different scaling factor in Projective synchronization approach, shape of the slave attractor becomes remarkably different from the master. Hence this method can be useful in synchronizing two different systems with different attractor. Parameters of controller are updated using an exhaustive search. Numerical simulation results, verify the significance of the proposed method for chaotic synchronization task.

Keywords. Fractional-order Differential Equations (FDEs), Chaos, Coullet system, Projective synchronization, ASMC.

1 Introduction

Although Fractional Order Calculus (FOC) has 300-year of history, its applications in physics and engineering have just begun (see [1]). In many systems, such as viscoelastic systems (see [2]), dielectric polarization, and electromagnetic waves, FOC models exhibited better utility. Furthermore, emergence of effective analytical and numerical methods in differentiation and integration of non-integer (fractional) order equations, in recent years, makes FOC more attractive for the control systems community. Recently the interest of chaotic synchronization has been extensively growth (see [3, 4, 5, 6, 7]). The fact that (see [8]) nonlinear chaotic systems may keep their natural chaotic behavior when their models become fractional has a critical effect in this manner. A pioneering work on the concept of “chaotic synchronization” is presented in (see [9]). Another’s work has been continued through presentation of a method to synchronize two identical chaotic systems with different initial conditions (see [10]). Different types of chaotic synchronization methods in terms of complete synchronization, generalized synchronization, phase synchronization and lag synchronization have been reported (see [11, 12, 13, 14, 15, 16]) . Recently, some researchers applied the fractional-order controller to control fractional and integer order dynamics of chaotic systems. In (see [17, 18]) an adaptive fractional controller is proposed to control and synchronize chaos, and controller parameter is updated based on a proper adaptation mechanism. A sliding mode control and active control is presented to synchronize the fractional-order chaotic system in (see [19, 20]). Fractional sliding mode is proposed to control chaos in (see [21]), and a fractional controller in combination with state feedback is proposed in (see [22]). In (see [23]) Bifurcation in fractional order Newton-Leipnik system was investigated. The projective method is used to synchronize fractional order rigid body system in [24]). other types of synchronization methods such as projective synchronization (see [24, 25, 26])and Active sliding mode control (ASMC) (see [27, 28, 29]) have been presented to synchronize fractional and inter order chaotic system. projective synchronization, which is characterized by a scaling factor, is a powerful synchronizing technique. IN this approach under certain conditions, not only the phase difference between the master and slave system is locked, but also their amplitudes of state vectors evolve in a proportional scale(see [30]). R. Maineiri and J. Rehacek studied Projective Synchronization in partially coupled linear chaotic systems such as the Lorenz system (see [30]). Later, D. Xuetal. (see [31, 32])investigated the conditions of Projective Synchronization in partially linear continuous and discrete-time chaotic systems in an arbitrary dimension. Active sliding mode control technique is a discontinuous strategy that relies on two stages of designation. The first step is to select an appropriate active controller to facilitate the design of sequent sliding mode controller. The second stage is to design a sliding mode controller to achieve the synchronization. this method is already applied to synchronize fractional order chaotic Coullet, L and Chen systems (see [27, 28, 29]).

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