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The Shortest Synchronization Time with Optimal Fractional Order Value Using a Novel Chaotic Attractor Based on Secure Communication

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ABSTRACT

In this study, a novel three dimensional autonomous chaotic attractor was found and secure communication masking application was performed with optimal fractional order, which offers more precise and faster results than first order chaotic equations, via Pecaro Carroll synchronization algorithm. The shortest synchronization time was investigated with optimal fractional order value. In the novel secure communication synchronization application with fractional order chaotic system, there is an angle of 45° between the signals sent and received, which clearly shows that the system can be employed in secure communication.

1. Introduction

Chaos is non-linear, irregular patterned and most complex steady-state behavior. It was previously believed that chaotic systems were very sensitive to initial conditions and system parameters and thus they werent appropriate for synchronization. In 1990, however, Pecora and Carroll proved that chaotic systems with different initial conditions could be synchronized [1,2]. In this study, a novel fractional order chaotic system was introduced and secure communication application was conducted via synchronization with P-C method. Secure communication application was made under Matlab Simulink environment. Experimental results show that the proposed chaotic system can be used in secure communication.

In their studies, Pecora and Carroll divided an original chaotic system into two separate parts and named them as driver and responder sub-systems. They managed to prove, both theoretically and experimentally, that when a replica of responder sub-system is created in receiver module and this sub-system is run with the driver part of the original system, chaotic synchronization can be possible; in other words, chaotic signal generated in receiver module will be very similar to the chaotic signal that come from the original system.

Following the P-C method, many other synchronization studies have been conducted and they have been utilized in secure communication applications. In their study, Pehlivan and Uyarolu carried out synchronization application with a single-parameter chaos model known as diffusionless Lorentz and demonstrated its usage in secure communication [3]. In their study, Pang et al. proved that global finite-time synchronization can be established between three dimensional Lorenz chaotic system and four dimensional Lorenz hyperkinetic system with known parameters or unknown parameters [4]. Ding and Xu studied chaotic synchronization of modified discrete time Tinkerbell systems [5]. Toopchi and Wang, in their studies, recommended an adjustable integral sliding mode control scheme for hyper chaotic Zhou systems synchronization [6]. Zhang et al. proposed a novel chaos synchronization scheme [7]. Moskalenko et al. proposed generalized synchronization of chaos for secure communication [8]. Grzybowski et al. proposed synchronization of the unified chaotic system and application in secure communication [9]. Synchronization studies for fractional order chaotic systems are also available. Moghaddas et al. made use of active sliding mode control strategy and synchronized fractional order Chen chaotic system [10]. Xu and Wang proposed fractional order sliding mode control method for the synchronization problem between fractional-order chaotic systems and Gaussian fluctuation [11]. Khanzadeh and Pourgholi [12,13] offered a method so that fractional order chaotic systems can be synchronized at any time desired. Chen et al. not only proposed a novel fractional order chaotic system but they also synchronized that

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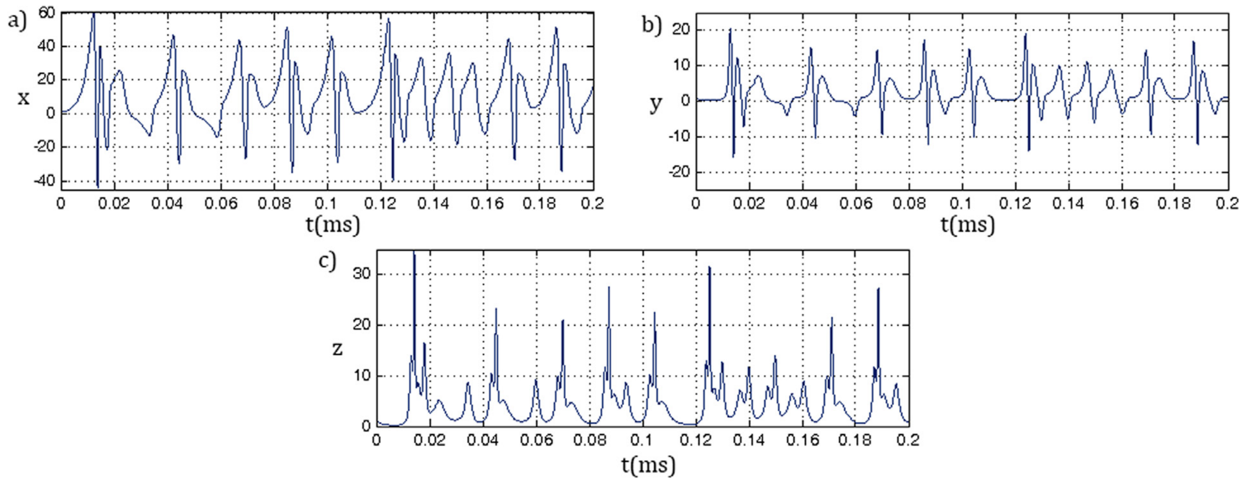

Fig. 1. *x*, *y* and *z* time series for proposed fractional order chaotic system.

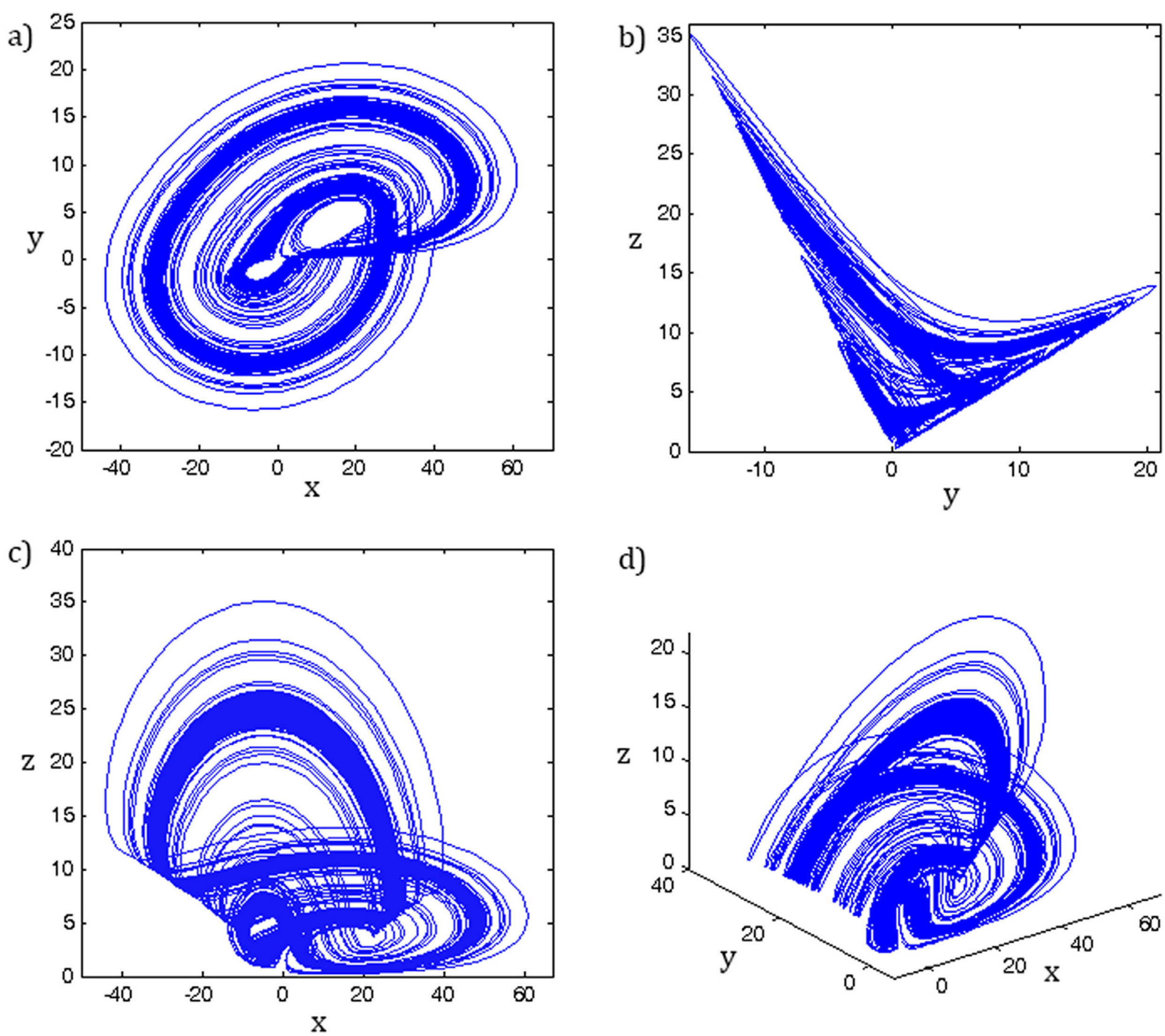

Fig. 2. Phase portraits of proposed fractional order chaotic system with $q = 0.9$: (a) $x - y$, (b) $y - z$, (c) $x - z$, (d) $x - y - z$.