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UNEXPECTED RESULTS OF EXTENDED FRACTIONAL KALMAN FILTER FOR PARAMETER IDENTIFICATION IN FRACTIONAL ORDER CHAOTIC SYSTEMS

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Abstract. *The Extended Fractional Kalman Filter (EFKF) for nonlinear discrete stochastic fractional order systems is studied in this paper. Perfect synchronization of chaotic systems is achieved by the EFKF algorithm in the presence of channel additive noise and processing noise. However, the EFKF has a limitation for the unknown parameter identification. The parameters do not converge to their real values in many circumstances. The reason for these failures is analyzed. Finally, based on the fractional Chen system, two numerical examples are provided to illustrate the effectiveness of the proposed method.*

Keywords: Parameter identification, Extended fractional Kalman filter, Synchronization, Fractional order system

1. **Introduction.** Over the past two decades, there has been tremendous interest in exploiting chaotic dynamics in communications. In chaotic communication schemes, the synchronization of the transmitter and the receiver system is essential for the reliable and accurate retrieval of information. The investigation of synchronization should date back to the 17th century. In 1673, Huygens gave a detailed description about the synchronization of two pendulum clocks with weak interaction. The first idea of synchronizing two identical chaotic systems with different initial conditions was introduced by Pecora and Carrols [1, 2], and the method was realized in electronic circuits. It was shown that if all of the sub-Lyapunov exponents for the response system are negative, then the systems synchronize asymptotically. Since then, much attention has been focused on developing the corresponding synchronization methods and schemes to achieve the synchronization of two dynamical systems [3]. Many methods and techniques have been developed, such as active control methods [4], adaptive control methods [5, 6, 7], sliding mode control methods [8, 9] and robust control methods [10, 11].

Fractional calculus is a mathematical topic with more than 300 years old history. Only in recent years, its applications to physics and engineering have attracted lots of attention. Kalman filter (KF) is one of the widely used stochastic estimation schemes in state estimation, tracking applications and other fields [12, 13, 14]. In fractional systems, the simplified Kalman filter for the linear case is called the fractional Kalman filter and its nonlinear extension is named as the extended fractional Kalman filter (EFKF). Nowadays, EFKF is not only an important algorithm for state estimation, but also an effective method for the implementation of chaos synchronization. In 2000, based on the EFKF, Cruz and Nijmeijer studied the performance for the synchronization of two different chaotic systems [15, 16]. Recently, Behzad et al. [17] presented an algorithm for