Conditions for the synchronization of bandlimited discrete-time chaotic systems

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Since Pecora and Carroll's seminal work [1], much has been written about the potential usefulness of chaotic synchronization in communication systems (e.g. [2, 5]). Much of the impetus for chaotic communications has been the rationale whereby both analog and digital chaotic modulations would have the same properties as conventional spread spectrum techniques [6]. However, the inherent wideband characteristic of chaotic signals becomes a problem when the communication channel imposes bandwidth limitations. Because of the receiver's nonlinear nature, all spectral components at the receiver become affected if any spectral component is amiss. Even minute gain or phase changes are enough to fully hinder synchronism [3]. A method for synchronizing both transmitter and receiver using chaotic signals under bandwidth limitations was independently proposed by [3] and [7]. The basic idea is to apply an identical filter on both transmitter and receiver in order to circumvent channel impairments. An analog circuit implementation was proposed by [3]. In [8] we have extended this method to discrete-time dynamical systems [7]. Much of the interest in this approach lies in the ease of employing Digital Signal Processors for their implementation. Although this approach has worked satisfactorily, numerical experiments have shown that depending on the filters employed, the generated signals could cease to be chaotic or diverge. In the current work we provide an analytical demonstration that synchronization is not affected when identical finite impulse response filters are included in both the transmitter and receiver. Furthermore, we numerically investigate for which filter's orders and cut-off frequencies it is possible to obtain chaotic signals. References [1] L. Pecora, T. Carroll, "Synchronization in chaotic systems," Physical Review Letters, v. 64, n. 8, p. 821-824, 1990 [2] T. Carroll, L. Pecora, "Synchronizing chaotic circuits," Circuits and Systems, IEEE Transactions on, v. 38, n. 4, p. 453-456, Apr 1991 [3] N. Rulkov and L. Tsimring, "Synchronization methods for communication with chaos over band-limited channels," International Journal of Circuit Theory and Applications, v. 27, p. 555-567,1999 [5] L. Torres, "Discrete-time dynamic systems synchronization: information transmission and model matching," Physica D: Nonlinear Phenomena, v. 228, n. 1, p. 31-39, 2007 [6] W. Tam, et al, Digital Communications with Chaos: Multiple Access Techniques and Performance. New York, NY, USA: Elsevier Science Inc., 2006 [7] M. Eisencraft, M. Gerken, "Comunicacao utilizando sinais caoticos: influencia de ruido e limitacao em banda," in Anais do XVIII Simposio brasileiro de Telecomunicacoes, Gramado, Brasil, 2001 [8] M. Eisencraft, R. Fanganiello, L. Baccala, "Synchronization of discrete-time chaotic systems in bandlimited channels," Mathematical Problems in Engineering, 12 pages, 2009. [Online]. Available: http://www.hindawi.com/journals/mpe/2009/207971.cta.html