Global combination synchronization in identical fractional-order chaotic systems using active control

Soumia. Bensimessaoud[1], **Smail. Kaouache** [2]

[1] Abdelhafid Boussouf University Center, Department of Mathematics and Computer Sciences, Mila, Algeria

[2] Abdelhafid Boussouf University Center, Department of Mathematics and Computer Sciences, Mila, Algeria

soumiabensimessaoud@gmail.com, smailkaouache@gmail.com

The purpose of this work is to ensure global combination synchronisation between two master fractional-order chaotic systems and one slave fractional-order chaotic system, by employing a suitable active control, the stability theory of fractional-order system. Numerical simulation results which are carried out using Adams-Boshforth Moulton are shown to demonstrate the validity and feasibility of the analytical results.

Definition 1. Let $n-1<p\leq n$, $n\in\mathbb{N}$, the Caputo fractional derivative of order p of function y is defined as

$$^{c}D^{p}y(t)=\frac{1}{\Gamma(n-p)}\int_{0}^{t}(t-\xi)^{n-p-1}y^{(n)}(\xi)d\xi \tag{1}$$

[6]

Theorem 1. *Consider the fractional-order linear system:*

$$^{c}D^{p}x=Ax, \tag{2}$$

where $x\in\mathbb{R}^n$ is the state vector. The previous system is asymptotically stable if and only if:

$$|arg(\lambda_i(A))|>\frac{p\pi}{2},$$

for $i=1,2,...,n$, where $arg(\lambda_i(A))$ denote the argument of the eigenvalue λ_i of A.

[5.P.963-968]

Now, we introduce the general scheme of the GCS of three identical fractional-order systems by using active control method.The general model can be given as follow.

$$D^{p}x=f(x), \tag{3}$$

$$D^{p}y=g(y), \tag{4}$$

and the response system is assumed by:

$$D^{p}z=h(z)+u, \tag{5}$$

where $p\in(0,1)$ is the fractional order, $x=(x_1,x_2,...,x_n)^T$, $y=(y_1,y_2,,...,y_n)^T\in\mathbb{R}^n$ are the state vectors of the drive systems,and $z=(z_1,z_2,...,z_n)^T\in\mathbb{R}^n$ is the state vector of the response system $f,g,h:\mathbb{R}^4\to\mathbb{R}^n$ are the continuous functions and $u=(u_1,u_2,,...,u_n)^T\in\mathbb{R}^n$ is the controller vector which will be designed.

Definition 2. The two drive systems (3) -(4)and the response system (5) are said to achieve the GCS if there exists a suitable controllers $u_i = 1, 2, ...n$ such that the error states

$$e_i = x_i + y_i - z_i, i = 1, 2, ...n$$

will approach zero for large enough t.

1. Pan L., Xu D., Zhou W. Controlling a novel chaotic attractor using linear feedback, Journal of Informatics and Computer Science, Vol. 5,2010, pp 117-124.
2. Lü J., Chen G. A new chaotic attractor coined. International Journal of Bifurcation and Chaos, Vol.12, 2002, pp. 659-661.
3. Luo R. Z., Wang Y. L. Finite-time stochastic synchronization of three different chaotic systems and its application in secure communication. Chaos, 22, 2012.
4. Luo R., Wang Y., Deng S. Combination synchronization of three classic chaotic systems using active backstepping design. Chaos: An Interdisciplinary Journal of Nonlinear Science, 21, 2011, 4.
5. Matignon D. Stability results for fractional differential equations with applications to control processing. Comput. Eng. Syst. Appl, 2, 1996, 963-968.
6. M Caputo. Linear models of dissipation whose Q is almost frequency independent. Geophys. J. R. Astron. Soc, 13, 1967.