Chaotic oscillator from a PMSM model using DS

Luis Nestor Coria[1,2], Konstantin E Starkov[2], Arturo Sotelo[1], Ivan Contreras[1], Ramon Ramirez[1], & Paul Valle[1]

[1] Instituto Tecnologico de Tijuana. Blvd. Industrial s/n, Mesa de Otay, Tijuana, BC, Mexico.
[2] CITEDI-IPN. Av. del Parque 1310, Mesa de Otay, Tijuana, BC, Mexico.
luis.coria@gmail.com

Dynamical properties of chaotic systems suggest complexity for a physical implementation. This paper presents a chaotic oscillator using the TMS320C6713 DSP. The implemented chaotic oscillator corresponds to a scaled version of the model of a permanent-magnet synchronous motor (PMSM) that presents chaos for some values of its parameters, this model was presented and discussed in **[1]** and is given by the following equations:

$$\begin{aligned}\dot{x} &= 20(-bx + 200yz);\\ \dot{y} &= 20(-y - 200xz + cz);\\ \dot{z} &= 20(a(y - z) + 200\xi xy).\end{aligned}$$

Traditionally, a chaotic oscillator is implemented with analog components, but this has changed because of many benefits provided by a DSP [2]. Time series of all state variables of the chaotic oscillator with DSP were obtained and three different metods were applied in order to establish its chaotic properties. We found: 1) The largest positive Lyapunov exponent; 2) Poincare map; and 3) Fourier Transform. Chaotic signals can be used in data encription [3], [4], and generate chaos like behavior in some physical application where it is desired [5], and so on. This work was supported by SEP-CONACYT project 78890 and DGEST project TIJ-IET-2009-217, MEXICO.

References

1. Z. Jing, C. Yuc, and G. Chen, "Complex dynamics in a permanent-magnet synchronous," *Chaos, Solitons and Fractals*, vol. 22(4), pp. 831–848, 2004.
2. P. Lapsley, *DSP Processor Fundamentals*. IEEE Press, 1997.
3. H. Xiao and W. Zeng, "A hard disk encryption system realized by the digital signal processor," *International Conference on Computational Intelligence and Security*, vol. 2, pp. 312–314, 2009.
4. R. Saravanan, T. Sivaramakrishnan, and K. Ramamoorthy, "A new approach on discrete chaotic cryptography using TMS320C6713 digital signal processors," *International Journal of Applied Engineering Research*, vol. 2, no. 3, pp. 545–556, 2007.
5. S. Ye, K. Chau, and N. Shuangxia, "Chaoization of a single-phase induction motor for washing machines," in *Industry Applications Conference, 2006. 41st IAS Annual Meeting.*, IEEE. IEEE, 2006, pp. 855 – 860.