Hyperchaotic Control by Thresholding Method

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Abstract - **In this paper proposed a modified experimental control of hyperchaotic oscillations using threshold method. Shows an experimental scheme for control of hyperchaotic oscillations.**

Keywords – **Chaos, control, threshold.**

I. Introduction

In recent years, there has been intense research activity devoted to the design of effective control techniques. A large body of work derives from the Ott, Grebogi, and Yorke (OGY) idea [1], which seeks to use small perturbations to place chaotic orbits onto unstable periodic orbits. In this paper, we demonstrate an alternate control strategy: the simple and easily implementable threshold mechanism. This strategy does not involve adjusting any parameter in the system, but only involves the occasional resetting of one state variable.

II. Experiment

We consider the realization of four coupled nonlinear ordinary differential equations of the form

$$\dot{x}_1 = (k-2)x_1 - x_2 - G(x_1 - x_3), \qquad (1)$$

$$\dot{x}_2 = (k-1)x_1 - x_2, \qquad (2)$$

$$\dot{x}_3 = -x_4 - G(x_1 - x_3), \qquad (3)$$

$$\dot{x}_4 = bx_3, \qquad (4)$$

where

$$G(x_1 - x_3) = \frac{1}{2}b\left[|x_1 - x_3 - 1| + (x_1 - x_3 - 1)\right]$$

with $k = 3{,}85$, $b = 88$, and $b = 18$ [2]. The circuit realization of the above is displayed in Fig. 1, with component values: $C1 - C3 = 68nF$, $C4 = 1nF$, $DA1 - DA6 = TL082$, $GB1 =$ threshold reference voltage, $R1 = 1k\Omega$, $R2 = 1{,}8k\Omega$, $R3 = 2{,}8k\Omega$, $R4 = 1{,}8k\Omega$, $R5, R6 = 1k\Omega$, $R7 = 56\Omega$, $R8, R9 = 1k\Omega$, $R10 = 100k\Omega$ and $VD1 - VD3 = 1N4148$.

We implement a partial thresholding on variable x_3: whenever $x_3 > x^*$ in the system, $G(x_1 - x_3)$ in Eq. (1) becomes $G(x_1 - x^*)$, i.e., we have $\dot{x}_1 = (k-2)x_1 - x_2 - G(x_1 - x^*)$, while Eqs. (2)-(4) are unchanged. When $x_3 \le x^*$, there is no action at all. A precision clipping circuit as depicted in the dotted box in Fig. 1 is employed for the above scheme, which is even simpler to implement than thresholding x_3 throughout the system. We have chosen component values for the control circuit to be operational amplifier DA1, diode VD3, series resistor $R9$ and threshold reference voltage GB1, which sets the x^*.

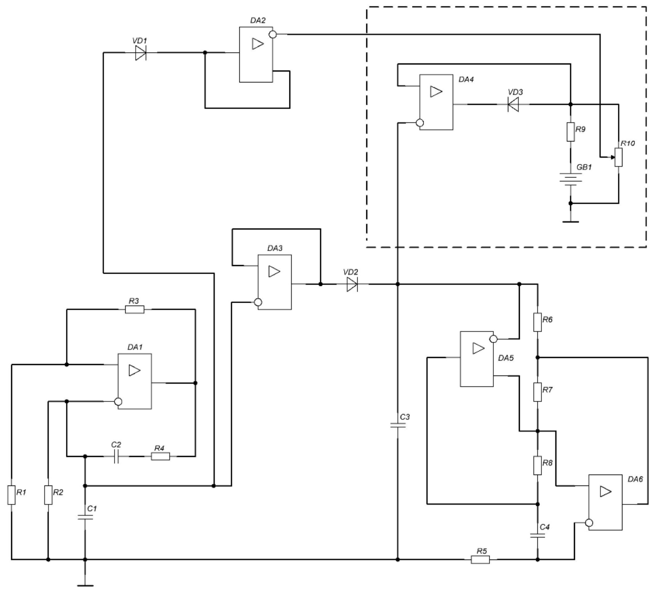

Fig. 1. Circuit implementation of Eqs. (1)-(4), with the precision clipping control circuit in the dotted box

III. Conclusion

This technique is powerful, efficient, and robust, and we have applied it successfully to obtain a wide range of regular behaviors. The method involves no adjustment of parameters, but merely the manipulation of one state variable. This method can be used for applications in such technical applications such as chaos computing and communications.

References

[1] E. Ott, C. Grebogi, and J. Yorke, *Phys. Rev. Lett.* 64, 1196, 1990.

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