ELSEVIER

21 August 1995

PHYSICS LETTERS A

Physics Letters A 204 (1995) 255–262

Stabilization of an unstable steady state in a Mackey–Glass system

A. Namajūnas, K. Pyragas, A. Tamaševičius

Semiconductor Physics Institute, 2600 Vilnius, Lithuania

Received 28 March 1995; revised manuscript received 23 June 1995; accepted for publication 26 June 1995
Communicated by A.P. Fordy

Abstract

We present theoretical and experimental results of stabilizing an unstable steady state in a Mackey–Glass system and its electronic analog driven into regions of hyperchaotic oscillations. Three stabilization methods based on conventional feedback, tracking filter, and delayed feedback are considered.

PACS: 05.45.+b

1. Introduction

Chaos in dynamical systems can seriously limit their performance in applications where a stable behaviour is important. In recent years there has been much interest in techniques which attempt to select one specific orbit of a chaotic system from an infinite variety of unstable behaviours and stabilize it with tiny feedback perturbations [1–14]. The techniques developed are based on either a discrete [1–6] (see also Ref. [15] for a survey) or a continuous [7–14] approach. The discrete techniques imply a preliminary analysis of the Poincaré map of the system and a subsequent adjustment of an accessible control parameter each time the system passes through a chosen Poincaré section. The time-continuous techniques are based on constructing permanent perturbations that leave unchanged the desired orbit of the system and change only its Lyapunov exponents in such a way that the orbit becomes stable. An important feature of all these techniques is that they are applicable to experimental situations in which a priori analytic knowledge of the system dynamics is not available [2–4,8–14]. The time-continuous approach does not require any preliminary or on-line computer analysis of the system dynamics and can be easily implemented in various experiments by a purely analog technique [8–12,14].

Most investigations in the field of controlling chaos deal with stabilization of unstable periodic orbits [1–12]. Since such orbits are dense in a typical strange attractor one can render a chaotic system periodic with a great variety of periodic behaviours by stabilizing distinct periodic orbits. One can also stabilize aperiodic orbits of the strange attractor by synchronizing the current behaviour of the system with its pre-recorded history [13,14]. Thus under the action of small perturbations an unpredictable chaos can be transformed into a predictable one. Along with unstable periodic and aperiodic orbits any autonomous chaotic system contains at least one unstable stationary point. These stationary points represent unstable steady states (USSs) of the system and can also be stabilized by feedback

0375-9601/95/$09.50 © 1995 Elsevier Science B.V. All rights reserved
SSDI 0375-9601(95)00480-7