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Boundedness of the New Modified Hyperchaotic Pan System

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Abstract: In this paper, we attempt to investigate the ultimate bound and positively invariant set for the new modified hyperchaotic Pan system using a technique combining the generalized Lyapunov function theory and optimization. For this system, we derive a four-dimensional ellipsoidal ultimate bound and positively invariant set. Furthermore, the two-dimensional parabolic ultimate bound with respect to $x-z$ is established. Finally, a numerical example is provided to illustrate the main result.

Keywords: *Pan system; upper bounds.*

Mathematics Subject Classification (2010): 65P20, 65P30, 65P40.

1 Introduction

In the last four decades, chaos as a very interesting nonlinear phenomenon has been intensively studied. Hyperchaotic system is usually defined as a chaotic system with more than one positive Lyapunov exponent. It is even more complicated than chaotic systems and has more unstable manifolds. At the same time, due to its theoretical and practical applications in technological fields, such as secure communications, lasers, nonlinear circuits, control, synchronization, hyperchaos has recently become a central topic in the research of nonlinear sciences.

In particular, the ultimate boundedness is very important for the study of the qualitative behavior of a chaotic system. If one can show that a chaotic or a hyperchaotic system under consideration has a globally attractive set, one knows that the system cannot have the equilibrium points, periodic or quasi-periodic solutions, or other chaotic or hyperchaotic attractors existing outside the attractive set. This greatly simplifies the analysis

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