Bifurcations and chaos of time delay Lorenz system with dimension 2n + 1

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Abstract:

The aim of this paper is to introduce a generalized form of the Lorenz system with time delay. Instead of considering each state variable of the Lorenz system belonging to R, the paper considers two of them belonging to Rn. Hence the Lorenz system has (2n + 1) dimension. This system appears in several applied sciences such as engineering, physics and networks. The stability of the trivial and nontrivial fixed points and the existence of Hopf bifurcations are studied analytically. Using the normal form theory and center manifold argument, the direction and the stability of the bifurcating periodic solutions are determined. Finally, numerical simulations are calculated to confirm our theoretical results. The paper concludes that the dynamics of this system are rich. Additionally, the values of the delay parameter at which chaotic and hyperchaotic solutions exist for different values of n using Lyapunov exponents and Kolmogorov-Sinai entropy are calculated numerically.

Keywords:

Time delay, Hyperchaotic, Hopf bifurcation, Stability, Lyapunov exponents

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