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STABILITY AND BIFURCATION ANALYSIS OF A TRI-NEURON NETWORK MODEL WITH DISCRETE DELAYS

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Abstract. In this paper, a tri-neuron network model with discrete delays is considered. By analyzing the associated characteristic transcendental equation, its linear stability is investigated and Hopf bifurcation is demonstrated. Some explicit formulae determining the stability and the direction of the Hopf bifurcation periodic solutions bifurcating from Hopf bifurcations are obtained by using the normal form theory and center manifold theory. Finally, numerical simulations supporting the theoretical analysis are given.

Keywords. Neural network; Stability; Hopf bifurcation; Discrete delay; Periodic solution.

AMS (MOS) subject classification: 34K20; 34C25; 91B64.

1 Introduction

Recently, the dynamics properties of (including stable, unstable, oscillatory and chaotic behavior) of neural networks with delays have become a subject of intense research activities (see, for example, [1, 2, 11, 14,23,24]) because of the successful application of neural networks to many fields such as intelligent control, optimization solvers, associative memories (or pattern recognition) etc. It is well known that neural networks are complex and large-scale nonlinear dynamical systems, while the dynamics of the delayed neural networks are even richer and more complicated [13]. In order to obtain a deep and clear understanding of the dynamics of neural networks, many researchers have focused on the studying of simple systems. One of usual ways is to investigate the delayed neural networks models with two or three neurons, see [1,12,18,20-22]. It is expected that we can gain some light for our understanding about the large networks by discussing the dynamics of two or three neurons networks. Compbell et al. [17] studied Compbell model with $n = 4$, and proved that a Hopf bifurcation can occur when the positive equilibrium loses stability. Zou et al. [15] considered a three-unit neural networks with two delays and obtained the conditions that guarantee the local stability of