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EXPONENTIAL STABILITY OF PERIODIC SOLUTIONS OF REACTION-DIFFUSION CELLULAR NEURAL NETWORKS WITH DELAYS

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Abstract. In the current paper, a delayed reaction-diffusion cellular neural networks with both the Dirichlet and Neumann boundary condition is studied. Several sufficient conditions guaranteeing its global exponential stability and the existence of periodic solutions are obtained through analytic methods such as Lyapunov functional and Poincaré mapping. Interestingly, the presented criteria depend on reaction-diffusion terms, which is a preeminent feature that distinguishes our research from the previous. Examples with numerical simulations are given to demonstrate the effectiveness of the results and method.

Keywords. Cellular neural networks; Reaction-diffusion; Delay; Lyapunov functional; Periodic solutions; the lowest eigenvalue.

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1 Introduction

In recent years, various neural networks, such as cellular neural networks (CNNs), Hopfield neural networks (HNNs), bidirectional associate memory (BAM) neural networks, Cohen-Grossberg neural networks(CGNNs), have attracted extensive interests of researchers from mathematics, physics, engineering, chemistry, biology and so on. They play important roles and have found successful applications in the fields such as pattern recognition, signal and image processing, nonlinear optimization problems, parallel computation, and other engineering areas[1-4,7-10,21]. As we know, these applications heavily depend on the dynamical behaviors. Studies on the dynamical behaviors of neural networks not only involve a discussion of stability properties, but also involve many dynamic behaviors such as periodic oscillatory behavior, bifurcation, and chaos [16,24]. In many applications, the properties of periodic oscillatory solutions and global exponential stability are of great interest. For example, the human brain is in periodic oscillatory or chaos [16],