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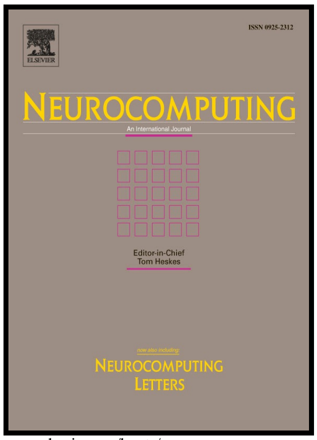

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Circuit implementation of digitally programmable transconductance amplifier in analog simulation of reaction-diffusion neural model

Miao Sun [a], Xing He [a*], Tiancai Wang [a] , Jie Tan [a] , Dawen Xia [b]

a. School of Electronics and Information Engineering, Southwest University, Chongqing 400715, PR China
b. School of Information Engineering, Guizhou Minzu University, Guiyang 550025, China

***Corresponding author: (Email address: hexingdoc@hotmail.com)**

Abstract— **This paper is concerned with circuit implementation in reaction-diffusion neuron model. Firstly, in order to realize easily, one obtains the equivalent form by discretization of this neuron model. In the frame of discrete model, every parameter can be represented by the basic circuit component. Then the digital programmable transconductance amplifier (DPTA) is designed to realize the digitally function in circuit. In addition, the DPTA is applied to realize two activation functions and the simulation results are verified in Multisim.**

Index Terms—**reaction-diffusion equation, neural network, circuit implementation**

INTRODUCTION

Nowadays, many kinds of neural network models are very common in our daily life and they are used in engineering and science widely [1-4, 26-29]. In the last few decades, various neural network models have been widely investigated and successfully applied to many kinds of research areas, such as image analysis, signal processing, pattern recognition, cryptography, associative memory, optimization, and model identification. Generally speaking, these models are described by ordinary differential equations where the neurons are well simulated. However, it is worth noting that the ordinary differential equation models ignore the spatial evolution at the level of neuron assemblies and cannot account for diffusion and reaction of neurons in biological systems. With the purposes that the good approximation of the spatiotemporal actions and interactions of actual neurons can be obtained, it is necessary to introduce the reaction-diffusion terms in neural network models. In [1], Chen et al. proposed a trainable reaction diffusion model for effective image restoration by extending conventional nonlinear reaction diffusion models and many applications have been investigated such as associative memory in [2], image processing in [3] and topology optimization in [4].

The synchronization and adaptive control in reaction–diffusion networks have been investigated deeply in some literature [5-11]. In [5], Wang et al. derived some sufficient conditions ensuring the passivity and global exponential stability by utilizing the Lyapunov functional method combined with the inequality techniques. In [6], Li et al. established the global exponential stability of the neural networks with its estimated exponential convergence rate by using the Lyapunov function method and M-matrix theory. In [7], Zhang and Xiao proved that the one-leg θ-method preserves stability and dissipativity of the underlying equations. In [8], Qiu considered the problems of global exponential stability and exponential convergence rate for impulsive neural networks with time-varying delays and reaction－diffusion terms. Moreover, others analysis methods are proposed on this such as impulsive control[9], hybrid coupling [10] and uncertain parameters [11].