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ANALYSIS OF DYNAMICAL BEHAVIORS FOR DELAYED NEURAL NETWORKS WITH INVERSE LIPSCHITZ NEURON ACTIVATIONS AND IMPULSES

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Abstract. *This paper develops a novel class of neural networks with inverse Lipschitz neuron activations and impulses. Based on the topological degree theory and matrix inequality techniques, we study the existence and uniqueness of equilibrium point of the neural network. By constructing suitable Lyapunov functions, a sufficient condition ensuring global exponential stability of the neural network is presented. Finally, two numerical examples further illustrate the correctness of the results obtained in this paper.*
Keywords: Neural networks, Global exponential stability, Impulse, Matrix inequality

1. **Introduction.** In application of neural networks either as associative memories (or pattern recognition) or as optimization solvers [1-5], it requires that neural networks have good stable properties, such as global asymptotic stability (GAS) and global exponential stability (GES). Particularly, when neural networks are employed as associative memories, the equilibrium points represent the stored patterns, and, the stability of each equilibrium point means that each stored pattern can be retrieved even in the presence of noise. When employed as an optimization solver, the equilibrium points of neural networks correspond to possible optimal solutions, and the stability of networks then ensures the convergence to optimal solutions. Also, stability of neural networks is fundamental for network designs. Due to these, finding the conditions ensuring stability of neural networks is very necessary. In the existing literature, almost all results on the stability of neural networks with or without time delays are conducted under some special assumptions on neuron activation functions. These assumptions frequently include those such as Lipschitz conditions, boundedness and/or monotonic increasing property (see, for instance, [6-11] and the references therein). When neuron activation functions do not satisfy Lipschitz conditions, people naturally want to know whether the neural network is stable. In practical engineering applications [14-16], people also need to present new neural networks. Therefore, developing a new class of neural networks without Lipschitz- continuous neuron activation functions and giving the conditions of the stability of neural networks are very interesting and valuable.

The model we consider in the present paper is the neural networks modelled by the impulsive differential system

$$\begin{cases} \dot{x}(t) = -Dx(t) + Ag(x(t)) + Bg(x(t-\tau)) + I, \quad t > 0, \quad t \neq t_k, \\ \triangle x(t_k) = J_k(x(t_k)), \quad k = 1, 2, ..., \end{cases} \tag{1}$$

where $x(t) = (x_1(t), \cdots, x_n(t))^{'}$ is the vector of neuron states at time t; $D = diag(d_1, \cdots, d_n)$ is an $n \times n$ constant diagonal matrix, $d_i > 0, i = 1, \cdots, n$, are the neural self-inhibitions;