PREFACE

Artificial neural networks are mathematical models in the form of electronic devices inspired by the nervous systems of living beings. Those have the ability to acquire and retain knowledge based on information. Artificial neural networks can be defined as a set of processing units, represented by artificial neurons, interlinked by a lot of interconnections, implemented by vectors and matrices of synaptic weights. For the application of artificial neural networks, it is necessary to investigate the stability analysis of their mathematical models. For example, when artificial neural networks are applied to associative memories, the designed systems must have "stable" equilibrium points. Moreover, to achieve synchronization state between artificial neural networks, error systems must be "stable". Furthermore, when artificial neural networks are designed to be implemented in certain engineering problems such as associative memories, pattern recognition, and signal processing, the designed system must have high storage capacity. Generally, there are two ways to improve the storage capacity of artificial neural networks. The first is to select multi-dimensional neurons, for example, quaternion-valued, or octonion-valued neurons, because multi-dimensional neurons hold more information than real-valued and complex valued neurons. The second is to increase the number of stable equilibrium points of the system, this is commonly known as the multistability of artificial neural networks. There are various kinds of multistability and synchronization that one can look into. In this thesis, some of those have been taken care of.

In the thesis, some problems on the multistability and synchronization of artificial neural networks have been discussed. This thesis is organized into six chapters. In Chapter 1, the artificial neural networks and their historical background are briefly introduced. This chapter gives an insight into types of artificial neural networks, and delay differential equations. Some definitions and the methods which will be used throughout the thesis have been added in this chapter.

Chapter 2 describes the existence of local multistable equilibrium points for delayed quaternion-valued neural networks with continuous piecewise nonlinear activation functions. In it, several new sufficient conditions for the existence of multiple locally stable equilibrium points have been achieved, without assuming monotonicity and linearity of the activation functions.

Chapter 3 explores the multiple μ-stability analysis of time-varying delayed quaternion-valued neural networks. In this chapter the concept of μ-stability analysis is discussed, which is a generalization of power stability, exponential stability and log stability. Herein, by applying some restrictions on delays, the concept of multiple μ-stability is discussed, which is a generalization of multiple power stability, multiple exponential stability, and multiple log stability.

Chapter 4 multistability analysis of octonion-valued neural networks with time-varying delays. This chapter shows the superiority of octonion valued neurons for associative memory application. In which, n-neurons octonion-valued neural networks can have 2^{8n} locally stable equilibrium points, which are obviously more as compared to respective complex-valued neural networks and quaternion-valued neural networks.

In Chapter 5, the fixed time synchronization of octonion valued neural networks with time varying delays have been discussed. The special feature of fixed time synchronization is that the system achieves the synchronization state in a finite time and the upper bound of the settling time is independent of the initial conditions.

Chapter 6 describes the summary of the thesis and the future work.