ABSTRACT

This thesis identifies some of the features and major limitations of current Artificial Neural Network (ANN) architectures and learning laws and explore an efficient method of classification using Coactive Neuro-Fuzzy Inference System (CANFIS) with genetic optimization for computer aided medical diagnosis. This system improves the initial and evolutorial precision of disease identification, reduces the doctors level of ambiguity regarding some diseases, allows monitoring the health status of the patient during new treatment methods, stores images in digital format and generates diagnosis databases that can be used in research, medical practice and specialized teaching. This is a highly important trans-disciplinary topic, combining aspects from bio-systems (human visual system), medical image acquisition and processing, artificial intelligence techniques (neural networks, fuzzy logic, genetic algorithms) and information management (databases).

The first stage in computer aided medical diagnosis is removal of noise from images. In image de-noising, a compromise has to be achieved between noise reduction and preservation of significant edges, corners and other image details. To achieve shift-invariance in medical images, Nonsubsampled Contourlet Transform (NSCT) is built upon non-subsampled pyramids and Non-Subsampled Directional Filter Bank (NSDFB) to achieve efficient noise removal. Existing image enhancement methods amplify noise when they amplify weak edges, since they cannot distinguish noise from weak edges. Since weak edges are geometric structures and noise is not, NSCT is used to distinguish them and it is one of the contributions of this thesis in the area of medical image de-noising.

Next stage in computer aided medical diagnosis is to identify the presence of the disease using CANFIS, a hybrid neuro-fuzzy system with multiple inputs and multiple outputs and its parameters are optimized with genetic algorithm. The main contribution of the thesis is the development of an effective and practical general CANFIS network for medical diagnosis. The efficiency of this network is analyzed and hypothesis testing using ANalysis Of VAriance (ANOVA) proved that classification accuracy is nearly same with and without dimension reduction techniques. Another contribution of this thesis is the use of Stern sequence for initializing the tuning parameters of ANN for quick training.