Chapter 4

Medical Image Classification Using an Optimal Feature Extraction Algorithm and a Supervised Classifier Technique

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ABSTRACT

A new approach for automated diagnosis and classification of Magnetic Resonance (MR) human brain images is proposed. The proposed method uses Wavelets Transform (WT) as input module to Genetic Algorithm (GA) and Support Vector Machine (SVM). It segregates MR brain images into normal and abnormal. This contribution employs genetic algorithm for feature selection which requires much lighter computational burden in comparison with Sequential Floating Backward Selection (SFBS) and Sequential Floating Forward Selection (SFFS) methods. A percentage reduction rate of 88.63% is achieved. An excellent classification rate of 100% could be achieved using the support vector machine. The observed results are significantly better than the results reported in a previous research work employing Wavelet Transform and Support Vector Machine.

1. INTRODUCTION

Magnetic resonance (MR) imaging is currently an indispensable diagnostic imaging technique in the study of the human brain (Neeraj et al., 2010). It’s a non-invasive technique that provides fairly good contrast resolution for different tissues and generates an extensive information pool about the condition of the brain. Such information has dramatically improved the quality of brain pathology diagnosis and treatment. However this big amount of data makes manual interpretation impossible.
and necessitates the development of automated image analysis tools. Computing technologies and systems may be classified into the categories of imperative, autonomic, and cognitive from the bottom up according to theories of cognitive informatics (Wang, 2009).

There is a variety of automated diagnostic tools that are developed by applying sophisticated signal/image processing techniques utilizing transforms and, may be, subsequently applying some computational intelligent techniques. In one possible methodology, the process of automatic segregation of normal/abnormal subjects, based on brain MRIs, is illustrated as a three-step process: feature extraction, feature selection and nonlinear classification.

To extract features from the MR brain images several image analysis methods are used: e.g. Gabor filters, Independent Component Analysis (ICA) (Moritz et al., 2000), techniques employing statistical feature extraction (like mean, median, mode, quartiles, standard deviation, kurtosis, skewness, etc.) (Begg et al., 2005), Fourier Transform (FT) based techniques (Bracewell, 1999), Wavelet Transform (WT) based techniques (Mallat, 89; Kharrat et al., 2009), etc. While Fourier Transform provides only frequency analysis of signals, Wavelet Transforms provide time-frequency analysis, which makes it a useful tool for time-space-frequency analysis and particularly for pattern recognition.

We use Genetic Algorithm (GA) to find minimum features subset giving optimum discrimination between extracted features. GA proves to be the most efficient compared with classical algorithms (Siedlecki et al., 1989) including sequential forward selection (SFS), sequential backward selection (SBS), sequential floating forward selection (SFFS) and sequential floating backward selection (SFBS).

We apply machine learning algorithms to obtain the classification of images under two categories, either normal or abnormal (Chaplot et al., 2006; El-Dahsan et al., 2009; Zacharaki et al., 2009). Support Vector Machines (SVMs) are widely used for classification tasks due to their appealing generalization properties and their computational efficiency.

The rest of the paper is organised as follows. Section 2 presents the Wavelet transform for feature extraction. Section 3 is devoted for feature selection employed for Genetic Algorithm. Image Classification is presented in Section 4. The performance evaluation, the feasibility and superiority of the proposed approach is conducted in Section 5. Finally, the section 6 presents our conclusions.

2. FEATURE EXTRACTION USING WAVELET TRANSFORM

For the feature extraction there is a wide variety of multi-resolution approaches mainly Fourier transform (FT) and wavelet transform (WT). Wavelets are mathematical tools for analysis of complex datasets. These mathematical functions decompose data into different frequency components and then study each component with a resolution matched to its scale. Compared with Fourier transform, wavelet transform seems as an efficient tool in many ways. The Fourier Transform suffers from the limitation that the provided image representation is based only on its frequency content and is not localized in time. Another problem is that the Fourier Transform cannot provide time evolving effects of frequencies in non stationary signals whereas wavelet transform functions provides a hierarchy of scales ranging from the coarsest scale in stationary or in non-stationary signals. Hence wavelet transform has received much attention as a promising tool for feature extraction from images because it can represent an image at various resolutions and because there is a wide range of choices for the wavelet functions.