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A Comparative Study of Different Techniques used for Brain Tumour Classification

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Abstract

Brain tumours are the most aggressive and devastating types of cancer and therefore, its correct identification at an early stage followed by treatment is its only cure. In this paper, a comparative study of three different techniques namely, Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT) and Principal Component Analysis (PCA) each separately combined with the Probabilistic Neural Network (PNN) is used for the classification of brain tumours. The system takes Magnetic Resonance Image (MRI) as input and classifies into benign or malignant tumours. The proposed system can be used to assist doctors in the clinical diagnosis of brain tumours.

Keywords: Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT), Principal Component Analysis (PCA), Probabilistic Neural Network (PNN).

1. Introduction

Brain is a soft mass of supportive tissues and nerve cells. These cells and the spinal cord together form the Central Nervous System (CNS). All the basic body functions like breathe, heartbeat, movement, coordination, the senses–vision, hearing, and even our personality is controlled by this system. Now, when these cells grow old or are damaged, they are replaced by the new cells. Sometimes, this process of cell division goes wrong and abnormal multiplication of cells takes place leading to tumour within the area. Thus, brain tumour can be defined as an abnormal mass of tissue that grows uncontrollably within the brain and interfering with the normal brain activity. They can be classified mainly into benign tumours and malignant tumours–the former originates within the brain with well-defined boundary with no cancer cells and the latter contains cancer cell, spreads rapidly to other body parts.

The signs and symptoms of brain tumours may occur gradually like a headache, nausea, blurred vision, balance problem or a seizure. Diagnosis methods include imaging techniques like computed tomography (CT or CAT scan) and magnetic resonance imaging (MRI). Magnetic Resonance Spectroscopy (MRS) to examine the tumour's chemical profile. Positron Emission Tomography (PET scan) to detect recurring brain tumours. Once tumour is detected it is treated with surgery, radiation, and/or chemotherapy — alone or in various combinations.

In this paper, a comparative study of classification of brain tumours into benign and malignant is done using DCT and PNN, DWT and PNN and finally, with PCA and PNN. MRI image is given as input to the proposed system.

2. Literature Survey

Kailash D. Kharat presented work on brain tumour classification using neural network in which DWT used for feature extraction, dimensionality reduction using PCA and a combination of two classifiers feed forward and back propagation neural networks were used for classification of tumour type with MRI and MRS data as input [1].

Flow Chart:

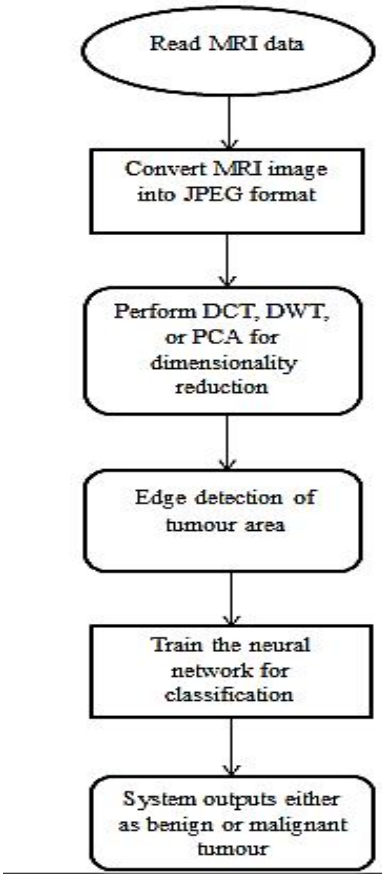

Fig. 1: Flow chart of the proposed system.

Asst. Prof. V. S. Kolge, worked on an automated classification of brain tumour using PCA for feature extraction and classification done using PNN [2]. A novel approach in brain tumour classification using artificial neural networks was presented by Madhusudhanareddy P in which image processing techniques were used for detection of tumour and back propagation method used for classification [3]. In the paper, "Binary Classification of Brain Tumours Using a Discrete Wavelet Transform and Energy Criteria", by Carlos Arizmendi, Alfredo Vellido, Enrique Romero, published in ©2011 IEEE, provides a combination of the Discrete Wavelet Transform (DWT) for signal decomposition and an energy criterion for signal reconstruction to pre-process the Magnetic Resonance Spectroscopy (MRS) data prior to feature selection and classification with Bayesian Neural Networks [4].

Discrete Cosine Transform: The Discrete Cosine Transform (DCT) helps separate the image into parts or spectral sub-bands of differing importance with respect to the image's visual quality. It transforms the image from spatial domain to frequency domain. The general equation for 2D (N by M image) DCT is defined by the equation :

$$F(u,v)=(2/N)^{1/2}\,(2/M)^{1/2}\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}\Lambda(i)\,\Lambda(j)\cos[\pi u(2i+1)/2N]\ \text{x}\ \cos[\pi v(2i+1)/2M].\ f(i.j). \quad (1)$$

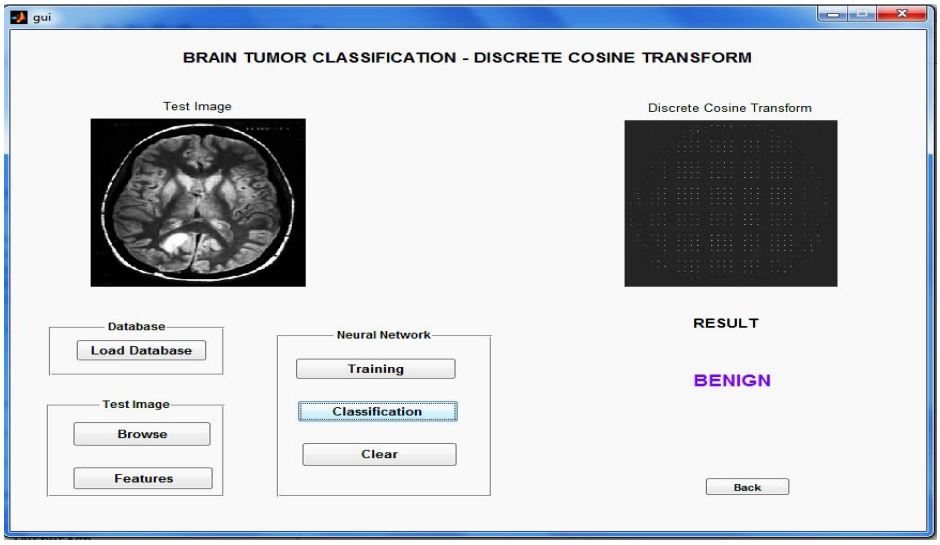

Fig. 2: Brain tumour detection using Discrete Cosine Transform.

Discrete Wavelet Transform: Wavelet transform performs multi–resolution of images that is simultaneous representation of images on different resolution levels. The wavelet compression techniques uses wavelet filters for decomposition into sub-images. First, filter is applied along the rows, then along the columns thus resulting in four sub-bands that is low-low, low-high, high-low and high- high. Hence, M x N image is filtered and then down sampled into N x M/2 images. Then each column is filtered and down sampled into N/2 x M/2 images.

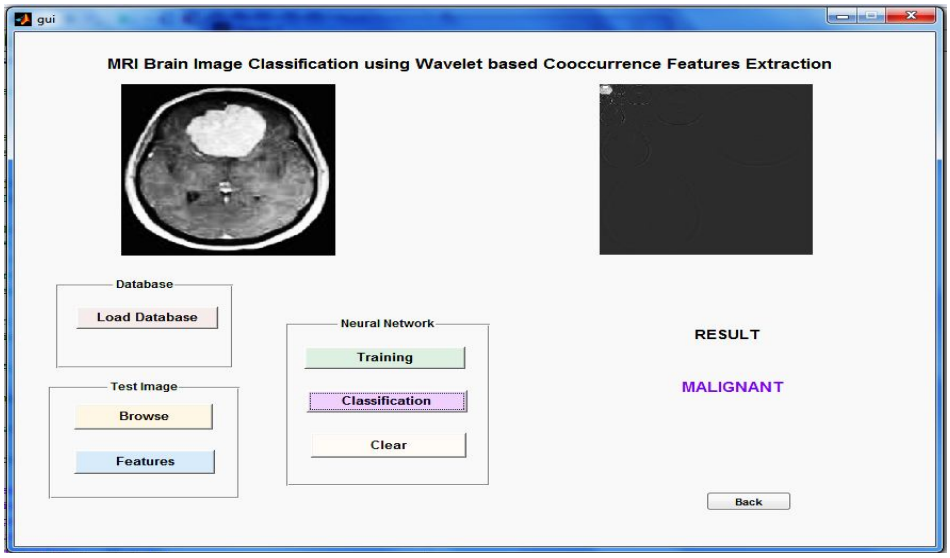

Fig. 3: Malignant tumour detected using Discrete Wavelet Transform.

Principal Component Analysis: Principal Component Analysis (PCA) is also known as Karhunen–Loeve transformation. This method is a transformation process where a new data space is formed with reduced number of features but has same dimension as the input data set.

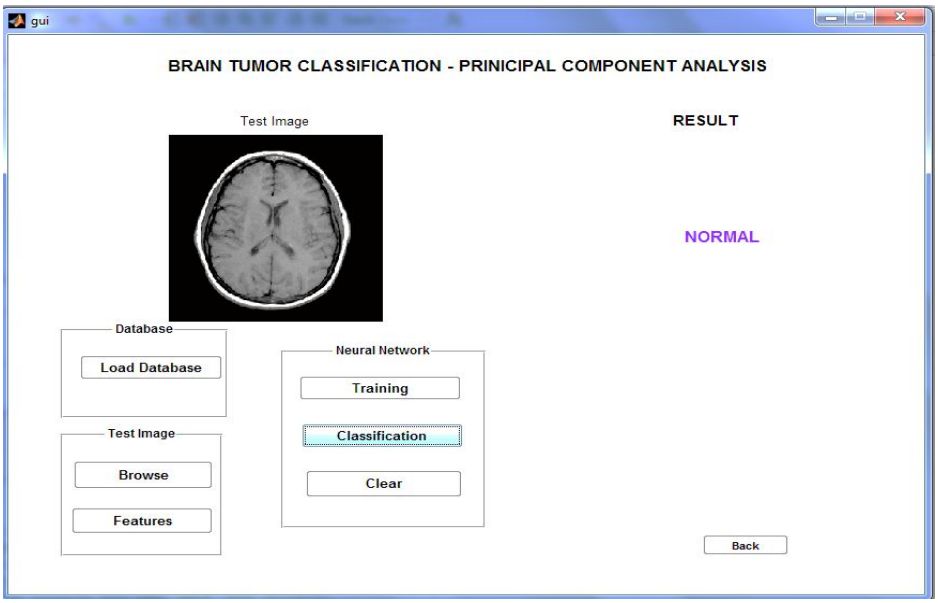

Fig. 4: Principal Component Analysis.

Probabilistic Neural Network: The Probabilistic Neural Network (PNN) is a Radial Basis Function suitable for pattern classification whose fundamental architecture has three layers–an input layer, a pattern layer and an output layer. The

pattern layer constitutes a neural implementation of a Bayes classifier, where the class dependent Probability Density Function (PDF) are approximated using estimator.

3. Conclusion

Three different techniques for the classification of brain tumour have been studied by training the database with 15 images using MATLAB R2012a software. The further work will be extended for classification of more types of brain tumours and also for the identification of other brain disorders.

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