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Brain Cancer Tumor Classification by PNN using GLCM Features and Genetic Algorithm based on KNN

A Dissertation
Submitted to the Department of Computer Science\ College of Sciences\ University of Diyala in a Partial Fulfillment of the Requirements for the Degree of Master in Computer Science

By

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

﴿يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنكُمْ
وَالَّذِينَ أُوتُوا الْعِلْمَ
دَرَجَاتٍ﴾

صدق الله العظيم

(سورة المجادلة :الآية11)

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Dedication

I would like to dedicate this work to:

To my candle that light my life

My Mother.

To My husband Ibrahim.

For his unlimited love, his supported,

His patience and Encouragement.

To My Brothers and Sisters

To All My Friends.

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Abstract

In past few years, cancer is one of the worst diseases in the world causing death of many people. MRI (Magnetic Resonance Imaging) is one of the widely used imaging techniques for detection and classification of brain tumors. The automatic detection and classification of image is considered very important for tumors human brain and very challenging task for medical images. Previously, this decision is taken manually by humans with the help of MRI (Magnetic resonance) or CT (Computerized Tomography) scan image of brain. But, these operations require for more time and the result may not be very accurate. Image may contain some noise due to error in machine performance which will result in inaccuracy and becomes hazardous to patient suffering from this disease. This thesis, describes the proposed system for brain tumors detection and classification along with the help of Artificial Neural Network.

The typical structure for the proposed system consists of several steps: Image Preprocessing with Mean and Median Filter Method, Feature extraction is done by using Gray Level Co-occurrence Matrix (GLCM) features and Feature selection by using Genetic Algorithm and K- Nearest neighbor classifier (K-NN) which are followed by Probabilistic Neural Network (PNN) is used for decision making.

The main advantage of this method is to give fast and accurate result with the help of training data set in addition to reduces time and computation power. The classification rate of this system performs 0˚= 98.57 %, 45˚= 100%, 90˚= 97.14% and 135˚= 98.57 % of accuracy.

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List of Abbreviations

Abbreviations	*Description*
ANN	Artificial Neural Network
ASM	Angular Second Moment
BP-ANN	Back Propagation-Artificial Neural Network
bck	Background
CT	Computerized Tomography
CSF	Cerebrospinal Fluid
DCT	Discrete Cosine Transform
DCvT	Discrete Curvelet Transform
DWT	Discrete Wavelet Transform
DMWT	Discrete Multiwavelet Transform
DV	Difference Variance
EM	Expectation Maximization
FOS	First Order Statistic
FF-ANN	Feed Forward -Artificial Neural Network
FF	Fitness Function
GBM	Glioblastoma Multiform
GA	Genetic Algorithm
GAFS	Genetic Algorithm Feature Selection
GM	Gray Matter
GLCM	Gray Level Co-occurrence Matrix
GLDM	Gray Level Dependency Matrix
GLSDM	Gray Level Spatial Dependency Matrix
GLRLM	Gray-Level Run Length Method
HSI	Hue, Saturation and Intensity
HL	High Low

HH	High High
IDM	Inverse Difference Moment
IMC	Information Measure Correlation
JPEG	Joint Photographic Experts Group
K-NN	K- Nearest Neighbor
LL	Low Low
LH	Low High
MCC	Maximum correlation Coefficient
MRI	Magnetic Resonance Imaging
MRA	Multi-Resolution Analysis
PCA	Principles Component Analysis
PNN	Probabilistic Neural Network
PNN-RBF	Probabilistic Neural Network -Radial Basis Function
PDF	Probability Density Function
Pm	Probability of mutation
Pc	Probability of crossover
ROI	Region of Interest
RGB	Red, Green, and Blue
RWS	Roulette Wheel Selection
SGLDM	Spatial Gray-Level Dependence Matrix
SLIC	Simple Linear Iterative Clustering
SOS	Second Order Statistic
SVM	Support Vector Machine
SE	Sum Entropy
SV	Sum Variance
SA	Sum Average
V	Variance
WBM	Whole Brain Atlas
WM	White Matter
WT	Wavelet Transform

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Chapter One

General Introduction

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General Introduction

1.1 Introduction

Today the processing of the medical image has seen considerable expansion. It has been a multidisciplinary research field attracting experience in applied mathematics, computer science, engineering, statistics, physics, biology, and medicine. Computer-aided diagnostic processing has really received a large part of clinical routine. Accompanied by the advance of modern development in the field of high technology and the use of different imaging techniques, show more challenges, the model, how to handle and analyze the important volume of images as it can produce high-quality information for disease diagnosis and therapy [1].

Medical image analysis is a significant medical radiography application uses medical images to diagnose diseases exactly. The detection and identification of the brain tumor from medical images are still a difficult task for a radiologist [2].

Along with rapid developments in image processing and image processing techniques, the diagnosis of tumors by computer is attracting more and more attention. Numerous achievements with the classification to describe an image based on metadata such as image enhancement features, texture or shape to give image depiction based on image content use of neural networks to classify images and distinguish between tumors [1].

Image processing is an effective field of research in the medical field and quite difficult. Medical image techniques are used to image the internal sections of the human body for medical diagnosis.

Image fragmentation plays an important role in image processing as it improves the extraction of suspicious areas from medical images. Image fragmentation of the brain is essential in the planning of surgical operations and planning treatment in medicine [3].

1.2 Medical Image Analysis

Today, because of the development of social economy and the increasing population, the medical diagnosis became more efficient and reliable. Medical image acquisition is very important to the diagnosis of disease. Therefore speeding up of medical image acquisition is very important to the detection of disease. The computational algorithms are used to diagnose diseases and as a specialist and significant assistant. These algorithms are used in several applications of medical imaging, image storage, and image management greatly [4].

Medical imaging is a technique and process used to create images of the human body for diagnosis, treatment and clinical research. Now, it's one of the fastest growing areas of medical technology. Methods commonly used for obtaining X-ray medical images are Computed Tomography (CT), Magnetic Resonance Imaging (MRI) and ultrasound imaging. In medical imaging, MRI is one of the scanning devices that use magnetic fields to capture images in films [3, 4].

The medical image analysis techniques have played a major role in many medical applications. In general, applications include the extraction of automatic features of the image that are subsequently used for a variety of classification tasks, such as the distinction between natural tissues from abnormal tissues.

Depending on a particular classification job, extracted features may be shaped properties, color properties, or some formative properties of the image [5].

1.3 Overview of Magnetic Resonance Imaging (MRI)

Magnetic Resonance Imaging (MRI) is a medical imaging technique used in body's internal structure and gives high-quality images. Radiations do not include radiation detection. So, they can be safely used in people who may be exposed to the radiation effect, such as pregnant women and babies [6]. Quick and reliable detection and classification of brain cancer are of significant technical and economic importance to the doctors [7].

An MRI scanner uses a strong magnetic field and radio waves to create pictures of the tissues and other structures inside the brain, on a computer. The magnetic field aligns the protons (positively charged particles) in hydrogen atoms, like tiny magnets. Short bursts of radio waves are then sent to knock the protons out of position, and as they realign, (relaxation time), they emit radio signals which are detected by a receiving device in the scanner. The signals emitted from different tissues vary, and can, therefore, be distinguished in the computer picture. An MRI scanner can create clear detailed pictures of the structure of the brain and detect any abnormalities or tumors. Sometimes a dye or tracer, such as gadolinium may be introduced via a vein in the arm, to improve contrast in the image. Images can be enhanced by differences in the strength of the nuclear magnetic resonance signal recovered from different locations in the brain [7].

MRI gives rich information about dissecting human tissues smoothly. The images obtained by MRI are used to analyze and study brain behavior, and assist in the diagnosis of a brain tumor [8].

The reliability, speed of detection and classification of brain cancer is of major technical and economic importance to physicians [9]. The schematic diagram of MRI equipment and inspection is shown in Figure 1.1[7].

Figure 1.1: The Schematic Diagram of MRI Equipment and Inspection [7]

The GM (Gray matter) of the brain consists of the cortex that lines the external surface of the brain and the gray nuclei deep inside of the brain, including the thalami and basal ganglia. The WM (White matter) constitutes a connected region that is bordered by GM and CSF (Cerebrospinal fluid) the display purpose WM is shown in gray color, GM as white color and CSF as black color. In MRI of head scans, the picture of the organ is usually surrounded by air particles, known as background (bck) in order to make a matrix representation. Figure 1.2 presents segmentation results of MRI [10].

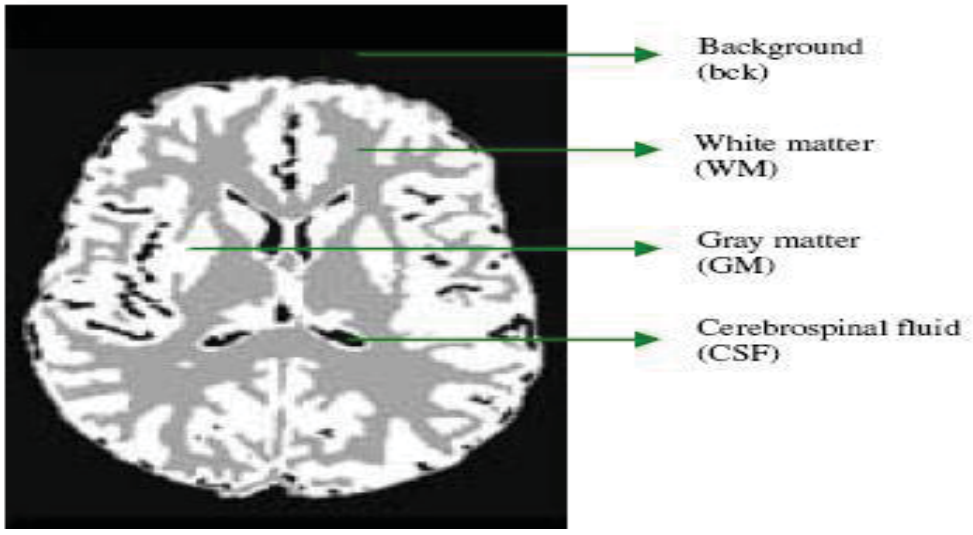

Figure 1.2: Segmentation Results of MRI [10]

1.4 Literature Survey

In this section, the study reviews some of the various approaches and techniques that are used for developing brain tumor detection systems are presented:

In 2017 Aswathy S., Devadhas G. and Kumar S. [11] designed a system for brain tumor segmentation using a genetic algorithm with SVM classifier. The proposed system consists of multiple steps. Step one is Pre-processing using the high pass, low pass and median filter for preprocessing. Step two, the segmentation by using a combination of the expectation maximization (EM) algorithm and the level set method. Step three, feature extraction and selection using GA. Step four, classification MRI brain image to normal or abnormal by using SVM. The present work segments the tumor using Genetic Algorithm and classification of the tumor by using the SVM classifier.

In 2016 Harsha G., Namita M. and Ankit V. [12] Proposed approach requires a brain MR image i as an input. The image is then preprocessed to remove noise and normalization are performed. Feature extraction is performed using the parameters given. Relevant features are then selected from the extracted features using GA and PCA with a population size of 100 individuals was found to yield the best accuracy. Classification is performed using KNN classifier. The KNN classifier was chosen because of ease of use and it works well on recognition problems. After classification, the algorithm returns the label of the tumor. The accuracy with GAFS is 75.28% and the accuracy with PCA is 62.92%

In 2016 Ata'a A. and Dhia A. [5] Proposed system is to detect and define tumor type in MRI brain images. It consists of multiple phases. Step one is preprocessing the MRI image, using several steps. Step two, transformations (features extraction algorithm based on using two level of 2-D discrete wavelet (DWT) and multiwavelet (DMWT) decomposition). Step three, the statistical measurements utilized to extract features from (GLCM). Step four, which deals with classification utilized PNN algorithm and the final phase is Step five, a proposed algorithm to segment, Superpixel Hexagonal Algorithm. The classification rate in the system of testing in DWT is 91% and in case DMWT is 97%.

In 2015 Pergad N. and Kshitija V. [13] designed a system for brain tumor extraction. This system consists of preprocessing for removing noise and Gray Level Co-occurrence Matrix (GLCM) for feature extraction method. Probabilistic Neural Network (PNN) is used for classification of the image into normal and abnormal. The last step is segmentation technique. The classification rate of the proposed system is 88.2%.

In 2015 Shobana G. and Ranjith B. [14] In this study, comparative of transform techniques Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT) each separately combined with the Probabilistic Neural Network (PNN) is used for the classification of MRI brain tumor. The system was defined by three stages for the diagnosis of MRI brain tumor. The first stage, MRI is obtained and preprocessing is done to remove the noise and Sharpen the MRI image. In the second stage, feature extraction by using DCT and DWT. In the third stage, classification of the MRI brain tumor by using Probabilistic Neural Network.

In 2015 Naveena H., Shreedhara K. and Mohamed R. [15] Proposed system is to exploit the capability of ANN in the classification of MRI images to either cancerous or non-cancerous brain tumor. K-means clustering algorithm was used for segmentation. Then, gray level co-occurrence matrix (GLCM) was used for feature extraction of segmented image. Finally, Backpropagation neural network (BPN) and Probabilistic Neural Network (PNN) is used for the classification of brain tumors. The overall accuracy of the presented system is 79.02% in case of BPN and 97.25% in case of PNN.

In 2014 Swapnali S. and Dimple C. [16] Proposed system is an automatic support system for classification stage using the artificial neural network (learning machine) and to detect MRI brain tumor through k-means clustering methods for the medical imaging application. It was performed in two stages: feature extraction based on DWT and using GLCM and PCA and then classification using PNN-RBF network. The performance of this classifier was evaluated in terms of training performance and classification accuracies. The simulated results showed that the classifier and segmentation algorithm provides better accuracy than the previous method with maximum recognition rate of 100%.