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MRI Brain Tumor Classification Using SVM and Histogram Based Image Segmentation

Chinnu A

Department of Computer Science and Engineering, Sarabhai Institute of Science and Technology, Vellanad, Trivandrum, India

Abstract: ***A brain tumor arises due to an abnormal growth of cells that have proliferated in an uncontrolled manner. When normal cells grow old or get injured, they either undergo cell death or get repaired by own. Research shows that people affected by brain tumors die due to their inaccurate detection. In this paper,proposed an intelligent classification technique to recognize normal and abnormal MRI brain image. Medical images like ECG, MRI and CT-scan images are important way to diagnose disease of human being efficiently. To avoid manual errors, an automated intelligent classification technique is proposed which caters the need for classification of image. In this paper work, classification techniques based on Support Vector Machines (SVM) and histogram based image segmentation are proposed and applied to brain image classification. Here feature extraction from MRI Images will be carried out by gray scale, symmetrical and texture features. This intelligent system improves accuracy rate and reduces error rate of MRI brain tumor classification using SVM.***

Keywords: Brain Tumor; MRI Brain Image; Support Vector Machines (SVM)

1. Introduction

A brain tumoris a disease in which cells grow uncontrollably in the brain. Brain tumors have mainly two types. First is Benign tumors are unable of spreading beyond the brain itself. Benign tumors in the brain generally do not essential to be treated and their progress is self- limited. Sometimes they can cause complications because of their position and surgery or radiation can be helpful. And second is Malignant tumors are typically called brain cancer. These tumors can extent outside of the brain. Malignant tumors of the brain will always change into a problem if left untreated and a violent approach is almost always warranted. Brain malignancies can be divided into two categories. Primary brain cancer originates in the brain. Secondary or metastatic brain cancer extents to the brain from another site in the body.

Cancer arises when cells in the body (in this case brain cells) divide without control. Generally, cells divide in a structured manner. If cells keep separating uncontrollably when new cells are not needed, a mass of tissue forms, called a progress or tumor. The term cancer generally refers to malignant tumors, which can attack nearby tissues and can extent to other parts of the body. A benign tumor does not extent.

Computer and Information Technology are very much useful in medical image processing, medical analysis and classification. Medical images are usually obtained by X-rays and recent years by Magnetic Resonance (MR) imaging. Magnetic Resonance Imaging (MRI) is used as a valuable tool in the clinical and surgical environment because of its characteristics like superior soft tissue differentiation, high spatial resolution and contrast. It does not use harmful ionizing radiation to patients. Magnetic Resonance Images are examined by radiologists based on visual interpretation of the films to identify the presence of anomalies.

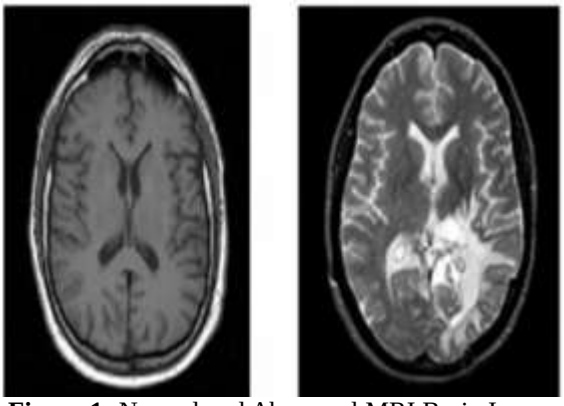

Figure 1: Normal and Abnormal MRI Brain Image

The MRI (figure 1) is the most commonly used modality for brain tumor growth imaging and location detection. The MRI images visual evaluation and examination by radiologists is subjective by its nature and is time consuming and prone to errors or omissions. Therefore analgorithmic image processing can assist radiologists in brain tumor diagnosis in multi-parametric MR images, especially since brain tumor detection and segmentation needs to take into account large variations in appearance and shape of structures. Hence there is a need for automated systems for analysis and classification of such medical images.

An intelligent classification technique is proposed to recognize normal and abnormal MRI brain image. Here classification techniques based on Support Vector Machines (SVM) are proposed and applied to brain image classification. Support vector machines can generalize well on difficult image classification problems where the only features are high dimensional histograms. This system for tumor detection and segmentation consists of several stages:

1) Input MRI Brain images.
2) Image preprocessing is used to improve the quality of images.
3) The obtained image with the removed noise is binarized by applying Histogram based image segmentation in order to extract the brain tumor.

4) Features will be extracted from the segmented images.
5) The reduced features are submitted to a support vector machine classifier to identify tumor.

In this paper we propose an intelligent classification technique to recognize normal and abnormal MRI brain image. This intelligent system improves accuracy rate and reduces error rate of MRI brain tumor classification using SVM. The classification techniques based on Support Vector Machines (SVM) and histogram based image segmentation are proposed and applied to brain image classification. The proposed intelligent system improves accuracy rate and reduces error rate of MRI brain tumor classification using SVM.

The remaining paper is organized as follows: Section 2 discuss about the various classification techniques of MRI brain tumor images. This section also focuses on the limitations of previous classification techniques. In Section 3, the proposed system has been described. Section 4 describes the architecture of proposed automatic intelligent classification technique. Section 5 summarizes the contents of this paper.

2. Related Works

R. J. Ramteke, KhachaneMonali Y[5] proposed a method for automatic classification of medical images in two classes Normal and Abnormal based on image features and automatic abnormality detection. KNN classifier is used for classifying image. K-Nearest Neighbour (K-NN) classification technique is the simplest technique conceptually and computationally that provides good classification accuracy. The K-NN algorithm is based on a distance function and a voting function in k-Nearest Neighbours, the metric employed is the Euclidean distance. SVM have high approximation capability and much faster convergence. KNN was chosen for classification purpose after verifying its classification accuracy with SVM. Normal Classified image displayed as resultant normal image. Abnormal classified image is passed to the next phase for further processing.

Khushboo Singh, SatyaVerma[8] proposed advanced classification techniques based on Support Vector Machines (SVM) are proposed and applied to brain image classification using features derived. SVM is a artificial neural network technique used for supervised learning of classification. Important characteristics of SVM are its ability to solve classification problems by means of convex quadratic programming (QP) and also the sparseness resulting from this QP problem. The learning is based on the principle of structural risk maximization. Instead of minimizing an objective function based on the training samples (such as mean square error), the SVM attempts to minimize the bound on the generalization error (i.e., the error made by the learning machine on the test data not used during training).

ShwetaJain[7] classifies the type of tumor using Artificial Neural Network (ANN) in MRI images of different patients with Astrocytoma type of brain tumor. The extraction of texture features in the detected tumor has been achieved by using Gray Level Co-occurrence Matrix (GLCM). An artificial neural network (ANN), generally called neural network (NN), is a mathematical model or computational model that is inspired by the structure and/or functional aspects of biological neural networks. A neural network contains of an interconnected group of artificial neurons (processing element), working in unison to solve specific problems. Back Propagation learning algorithm is a supervised learning algorithm. This learning algorithm is applied to multilayer feed-forward networks consisting of processing elements (neurons) with continuous differentiable activation functions (Tan- sigmoid and log-sigmoid). The networks associated with back-propagation learning algorithm are also called back-propagation learning networks (BPNs). For a given set of training input-output pair, this algorithm provides a procedure for changing the weights in a BPN to classify an input correctly. The concept for this weight update algorithm is basically the gradient-descent method as used in case of simple perceptron networks with differentiable units. This is a way where the error is propagated back to hidden unit.

Priyanka, BalwinderSingh[6] focused on survey of well-known brain tumor detection algorithms that have been proposed so far to detect the location of the tumor. The main concentration is on those techniques which use image segmentation to detect brain tumor. Image segmentation is the process of partitioning a digital image into multiple segments. The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyse. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. Using segmentation in medical images is a very important task for detecting the abnormalities, study and tracking progress of diseases and surgery planning. The segmentation of brain tumor can be done using various edge detection. Edge based segmentation is the most common method based on detection of edges i.e. boundaries which separate distinct regions. Edge detection method is based on marking of discontinuities in gray level, colour etc., and often these edges represent boundaries between objects. This method divides an image on the basis of boundaries. Numbers of edge detecting operators based on gradient (derivative) function are available. For brain tumor detection various edge detection operators are used which are sobel edge detection, prewitt edge detection operator and canny edge detection operator. From the three methods of edge detection, they found that Sobel method is more suitable for edge detection of brain tumor. This method has a little mean and standard deviation value.

Classifiers such as K-Nearest Neighbor[5] (KNN), Artificial Neural Network[7] (ANN) etc. are used for various applications such as hand written digit identification, object identification, speaker identification, face identification, text classification and for medical applications. Each of the classification schemes previously mentioned has its own unique properties and associated strengths and problems. In KNN, the major limitation is that it uses all features in distance computation ally intensive, mainly when the size of training set increases. Beside this, the accuracy of k-nearest neighbour classification is severely degraded by the presence of noisy or not related features, mainly when the

number of attributes grows.

3. Proposed System

A classification techniques based on Support Vector Machines (SVM) are proposed and applied to brain image classification and segmentation is also done by using Histogram based. The feature extraction from MRI Images will be carried out by gray scale, symmetrical and texture features. The main objective of this system is to give an excellent outcome (i.e. higher accuracy rate and lower error rate) of MRI brain cancer classification using SVM.

Medical images are corrupted by different type of noises like Rician noise etc. It is very important to have good quality of images for accurate observations for the given application. Median filter is used to remove noises while retaining as much as possible the important signal features. Skull masking is used to remove non-brain tissue like scalp, skull, fat, eyes, neck, etc., from MRI brain image. For skull masking morphological operations such as erosion and dilation is used. It helps to improve the speed and accuracy of diagnostic and predictive procedures in medical applications. Segmentation is the process of partitioning an image into multiple segments. It used to locate objects and boundaries in images. Based on Histogram representation, histogram is constructed by splitting the edges of sub images into equal-sized bins. For each bin, the number of points from the edge that fall into each bin is counted. Feature extraction refers to various quantitative measurements of medical images typically used for decision making. In this work 28 features are calculated for each image. Extracted feature set is applied to PCA. PCA is used to reduce the feature set which is extracted from images. The reduced features are submitted to a support vector machine for training and testing. Therefore this method will decrease the computation time and complexity. The classification process is divided into two parts i.e. the training and the testing part. Firstly, in the training part known data are given to the classifier for training. Secondly, in the testing part, unknown data are given to the classifier and the classification is performed after training part. The accuracy rate and error rate of the classification depends on the efficiency of the training.

4. System Architecture

The proposed automatic intelligent classification technique architectural diagram (fig. 2) is shown below:

Image pre-processing is used to improve the quality of images. Medical images are corrupted by different type of noises like Rician noise etc. It is very important to have good quality of images for accurate observations for the given application. Median filter is simple to understand. It preserves brightness differences resulting in minimal blurring of regional boundaries. It also preserves the positions of boundaries in an image, making this method useful for visual examination and measurement. MRI brain image is a RGB image. This image is first converted into gray scale image. Gray scale image is also known as an intensity image. Array of class pixel values specify intensity values. For single and double arrays, values range from [0, 1]. For uint8, values range from [0,255]. For uintl6, values range from [0, 65535]. For intl6, values range from [-32768, 32767]. Intensity or brightness of an image as two dimensional continuous function F(x, y) where (x, y) denotes the spatial coordinates when only the brightness of light is considered. Filtering is the process of removing noise from MRI images. Medical images are corrupted with different kinds of noise while image acquisition. Here median filter is used to remove noise from the MRI images. The median filter is a nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise.

The purpose of edge detection in general is to significantly reduce the amount of data in an image, while preserving the structural properties to be used for further image processing. Edges are significant local changes of intensity in an image. Edges typically occur on the boundary between two different regions in an image. The goal of edge detection is to produce a line drawing of a scene from an image of that scene and to extract important features from the edges of an image. These features are used by higher-level computer vision algorithms. Canny Edge Detector Algorithm is used for Edge Detection.

Segmentation is the process which divides an image into its constituent regions or objects. Segmenting non trivial images is one of the difficult tasks in image processing. Segmentation accuracy determines the eventual success or failure of computerized analysis procedure. Segmentation algorithms are based on one of two basic properties of intensity values discontinuity and similarity. First category is to partition an image based on abrupt changes in intensity, such as edges in an image. Second category is based on partitioning an image into regions that are similar according to predefined criteria. Histogram Thresholding approach falls under this category. Histogram is constructed by splitting the range of the data into equal-sized bins (called classes). Then for each bin, the number of points from the data set that fall into each bin is counted.

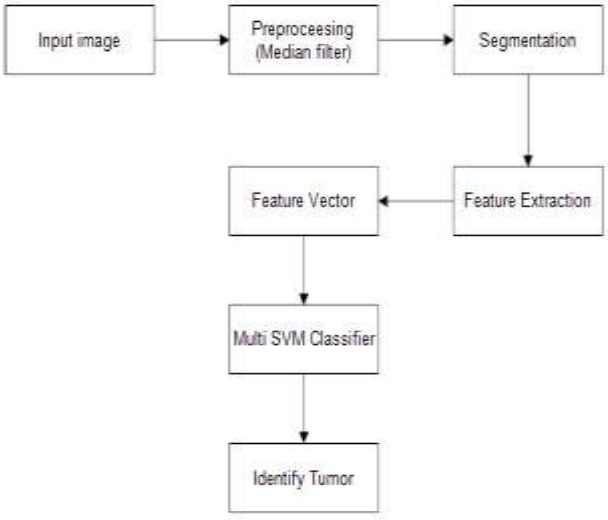

Figure 2: System Architecture

Feature extraction calculates features on the basis of which image can be easily classified as normal or abnormal one. The feature extraction is the process to represent raw image to facilitate decision making such as pattern classification. Features will be extracted from the tumor regions from MRI images. Feature extraction involves reducing the amount of data required to describe a large set of data accurately. Features are used as inputs to classifiers that assign them to the class that they represent. The intention of feature extraction is to reduce the original data by measuring positive properties, or features, that discriminate one input sample from another sample.

Excessive features used for classification not only increase computation time but also increase storage memory. They sometimes make classification more complicated. It is required to reduce the number of features. PCA is a proficient tool to reduce the dimension of a data set consisting of a large number of interconnected variables while retaining most of the variations. Reduce dimension means reduced feature set which is act as an input to the SVM during training part as well as testing part.

SVM algorithm was first developed in 1963 by Vapnik and Lerner. SVM is a binary classifier based on supervised learning which gives better result than other classifiers. SVM classifies between two classes by constructing a hyper plane in high-dimensional feature space which can be used for classification. SVM is a classification algorithm, which is based on different kernel methods.

5. Conclusion

Brain tumors are caused by abnormal and uncontrolled growing of the cells inside the brain.Treatment of a brain tumor depends on its size and location. Although benign tumors do not tend to spread, they can cause damage by pressing on areas of the brain if they are not treated early. To avoid manual errors, an automated intelligent classification technique is proposed which caters the need for classification of image. In this paper classification techniques based on Support Vector Machines (SVM) are proposed and applied to brain image classification. Here also proposed brain tumor image segmentation based on Histogram thresholding. This automated intelligent system results in the improvement of accuracy rate and reduces the error rate of MRI brain tumor.

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