Classification of Brain Lesion and Grade Using MRI Texture and Shape in Machine Learning Scheme

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ABSTRACT

The number of persons infected by brain lesion increases every year. lesion are caused by abnormal growth of cells. Brain lesion can be benign (noncancerous lesions) or malignant (cancerous). They are also classified as primary and secondary. Primary lesion start in the brain or Central Nervous Systems whereas the secondary lesion spread from other body parts into the brain. Depending on the degree of abnormality of brain tissue, the lesion are typecast into four grading lesion are high-grade lesion that are highly susceptible to cancer.

Classifying brain lesion using machine learning techniques have become an essential due to its importance in people life. The correct and fast diagnosis are the keys to reduce the percentage of deaths that have raised recently to significant numbers. The available techniques such as CT scan and MRI imaging are widely used nowadays and the latter is more common as it provides high resolution images from different angles for brain tissues. Determining the right type of brain lesion manually requires an expert who has a good knowledge in brain diseases. Also, it is time consuming and tedious for a lot of images. Moreover, human errors are possible and consequently false detection may cause a wrong procedure and treatment. Therefore, the scientists and researchers introduced different approaches for classifying lesion types automatically and efficiently without needing to human knowledge..

Keywords: brain tumpor, Lesion, CNN, MRI, Classification.

INTRODUCTION

A brain tumor is collection of the abnormal cells in the brain. A tumor may lead to cancer, which is a major leading cause of death. The cancer rate is growing at an alarming rate in the world, nearly 11% of people are died every year due to the cancer. The abnormal growth of cells and division of that cells in the brain may lead to brain tumor, and the further growth of brain tumors may leads to brain cancer. So, detection of the tumor is very important in their earlier stages. Great knowledge and experience on radiology are require for accurate tumor detection in medical imaging processing. The brain tumor is depending upon the combination of factors like the type of tumor, its position, its size, Grade of tumor and its state of growth.

This project deals with such a system, which uses computer and mobile based procedures to detect the tumor parts and classify the type and grade of tumor using Convolution Neural Network (CNN) Algorithm for MRI images of different patients. Different types of image processing techniques like image segmentation technique, image enhancement technique and feature extraction technique which are used for the brain tumor detection in the MRI images of the cancer- affected patients.

Based on our machine, we will predict whether there is any brain tumor or not. The resultant outcomes will be examined through various performance examined metrics that include accuracy, sensitivity, and specificity, etc. Detecting the Brain tumor using various Image Processing techniques that are involves the four stages which are Image Pre-Processing, Image segmentation, Feature Extraction, and Classification. Image processing and neural network techniques are used for improve the performance of detecting and classifying brain tumor in MRI images.

METHODOLOGY

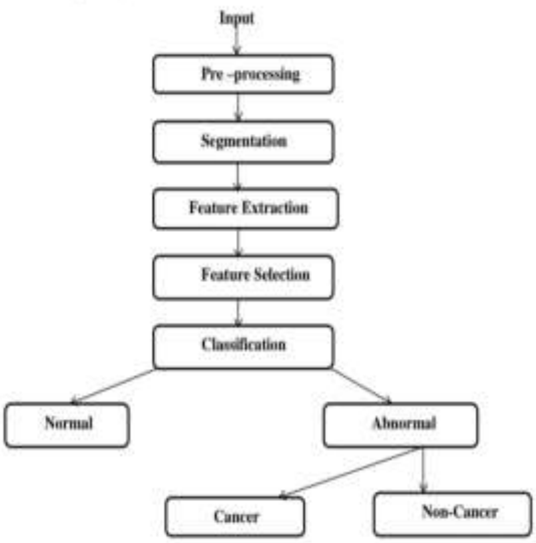

Figure 1: Classification of brain lesions

1. IMAGE PREPROCESSING AND IMAGE ENHANCEMENT

We take Dataset of Brain MRI image from the Kaggle. The MRI dataset consists of a MRI images, including normal, benign, and malignant and No Tumor. These MRI images are taken as input to the primary step. The pre-processing is an essential and initial step in improving the quality of the brain MRI Image. The critical steps in pre-processing are the reduction of impulsive noises and image resizing. In the initial phase, we convert the brain MRI image into its corresponding gray-scale image. The removal of unwanted noise is done using the technique called adaptive bilateral filtering technique to remove the distorted noises that are present in the brain images. This improves the diagnosis and also increase the classification accuracy rate.

IMAGE ENHANCEMENT:

Image enhancement is a technique used to improve the images quality by applying various computer-aided softwares. This Image Enhancement technique includes both objective and subjective enhancements. This technique includes on points and local operations. The local operations depend on the district input pixel values. Image enhancement has two types: Spatial and Transform domain techniques. The Spatial techniques work directly on the pixel level, while the transform technique works on the spatial technique.

IMAGE SEGMENTATION USING BINARY THRESHOLD

Image segmentation is a technique of segregating the image into various parts. The main aim of the segregation technique is to make the images easy to analyze and interpret with preserving the quality of image. This technique is also used to trace the objects borders within the images i.e. Edge detect. This technique labels the pixels according to their intensity and characteristics. Those parts represent the entire original image and acquire its characteristics such as intensity and similarity. The image segmentation technique is used to create contours of the body for clinical purposes. Segmentation is used in machine perception, malignant disease analysis, tissue volumes,

anatomical and functional analyses, virtual reality visualization, and anomaly analysis, and object definition and detection. Segmentation methods has ability to detect or identify the abnormal portion from the image which is useful for analyzing the size, volume, location, texture and shape of the extracted image.

THRESHOLDING

Thresholding is the simplest method of image segmentation. It is a non-linear operation that converts a grey-scale image into a binary image where the two levels are assigned to pixels that are below or above the specified threshold value. In Open CV, we use cv2.threshold() function:
cv2.threshold(src, thresh, maxval, type[dst])

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This function applies fixed-level thresholding to a single-channel array.

Morphological Transformations :

Morphological transformations technique removes noise from a brain to make sure that all brain is converted to white, to manage from removing boundary (skull) without effect on other parts of a brain. That is mainly done by the morphology transformation. Morphological transformations are some simple operations on binary images.

Edge Detector: We detecting tumor by using Canny Edge Detector which is developed by John F in 1986. Canny Edge detector technique aims to satisfy three main criteria i.e. low error rate, good localization, and minimal response.

Steps of Canny Edge Detector:

1. Noise Reduction: First step is to remove the noise in the image with a 5x5 Gaussian filter.

2. Finding Intensity Gradient of the image: A) Filtering with Sobel kernel in both horizontal (Gx) and vertical direction (Gy). B) Find the gradient strength and direction.

FEATURE EXTRACTION AND SELECTION

Features are the main properties that quantify significant characteristics of the object. After getting an image when ending segmentation, start features steps on an original image. Applying features selection then feature reduction using PCA (Principal component analysis) is used.

Feature extraction : Extraction stage is an important step to identifying the brain tumor where is exactly located and helps in predicting next stage. There are three kinds of features can be selected and extracted.

Texture features: based on surface properties. Such as homogeneity, energy…etc.

Shape features: based on the boundary of an image. Such as: area, Centroid , Compactness.

Intensity: based on region properties. Such as: median, intensity …etc.

Area: Calculate a number of pixels in the region. For Calculating area, we need to calculate its zeroes moment In a binary image, there are two possibilities 0 or 1, so in white pixel add 1 to moment to get all area.

Centroid : Cendroid are the coordinates for the region center of mass.

Compactness : Calculated from dividing the area by perimeter square, where perimeter is the length of the boundary of the object, when region more likely to be a circle it goes to maximum compactness Eccentricity The ratio between the major axis and the minor axis in the region detected, when the ratio is 1, the region becomes a circle.
Major axis (A): longest horizontal axis in region. Minor axis (B): longest vertical axis in region.

Eccentricity = length of A / length of B

Methods of feature reduction

Principal Component Analysis (PCA):
Principal Component Analysis (PCA) is a statistical procedure that orthogonally transforms the original n coordinates of a data set into a new set of n coordinates called principal components.

Random Forests / Ensemble Trees:

Decision Tree Ensembles, also referred to as random forests, are useful for feature selection in addition to being effective classifiers. One approach to dimensionality reduction is to generate a large and carefully constructed set of trees against a target attribute and then use each attribute‟s usage statistics to find the most informative subset of features.

1 -Texture Feature: ASM - Mean - Standard deviation- contrast -correlation - dissimilarity - energy- homogeneity - kurtosis - skew

2 -Shape Feature: Area - convex area - Eccentricity - Solidity - Euler number - Extent - Orientation

Evaluating a Classifier

Classification accuracy: Is the percentage of Correct Predictions, it computed using the true test class labels and predicted class labels.

Confusion Matrix: Table that describes the performance of a classification model. Every observation in the testing set is represented in exactly one box It's a 2x2 matrix because there are 2 response classes The format shown here is not universal

Basic terminology :
1. True Positives (TP): we correctly predicted that they do have cancer .
2. True Negatives (TN): we correctly predicted that they don't have cancer.
3. False Positives (FP): we incorrectly predicted that they do have cancer (a "Type I error").
4. False Negatives (FN): we incorrectly predicted that they don't have cancer (a "Type II error").

Sensitivity: when the actual values are positive, how often the prediction is correct or how 'sensitive' is the classifier to detecting positive instances. Also known as 'true positive rate ' or recall:

Specificity: when the actual value is negative, how often is the prediction correct or how 'specific' or 'selective' is the classifier in prediction positive instances:

Precision: when a positive value is predicted, how often the prediction is correct or how "precise" is the classifier when predicting positive instances:

Performance measures: The proposed algorithm has been assessed through various performance evaluation metrics that include True Positive, True Negative the former one that designates how many times does the proposed algorithm is able to correctly recognize the damaged region as damaged region and the later one designates how many times does the proposed algorithm correctly identified non-damaged region as non-damaged region. And the False Positive (FN) and False Negative (FN) the former one designates how many times does the proposed algorithm fails to recognize the damaged region correctly, and the later represents how many times does the proposed algorithm fails to identify the non-tumors region as non-tumors regions. Basing on values of TP, TN, FP, and FN, the values of Accuracy, Specificity and sensitivity are calculated of the proposed algorithm.

Scope:
Our aim is to develop an automated system for enhancement, segmentation and classification of brain tumors. The system can be used by neurosurgeons and healthcare specialists. The system incorporates image processing, pattern analysis, and computer vision techniques and is expected to improve the sensitivity, specificity, and efficiency of brain tumor screening. The primary goal of medical imaging projects is to extract meaningful and accurate information from these images with the least error possible. The proper combination and parameterization of the phases enables the development of adjunct tools that can help on the early diagnosis or the monitoring of the tumor identification and locations.

Overview : The focus of this project is MR brain images tumor extraction and its representation in simpler form such that it is understandable by everyone. The objective of this work is to bring some useful information in simpler form in front of the users, especially for the medical staff treating the patient. The aim of this work is to define an algorithm that will result in extracted image of the tumor from the MR brain image. The resultant image will be able to provide information like size, dimension and position of the tumor, and its boundary provides us with information related to the tumor that can prove useful for various cases, which will provide a better base for the staff to decide the curing procedure. Finally, we detect whether the given MR brain image has tumor or not using Convolution Neural Network.

Conclusion: We proposed a computerized method for the segmentation and identification of a brain tumor using the Convolution Neural Network. The input MR images are read from the local device using the file path and converted into grayscale images. These images are pre-processed using an adaptive bilateral filtering technique for the elimination of noises that are present inside the original image. The binary thresholding is applied to the denoised image, and Convolution Neural Network segmentation is applied, which helps in figuring out the tumor region in the MR images. The proposed model had obtained an accuracy of 84% and yields promising results without any errors and much less computational time.

Future scope: It is observed on extermination that the proposed approach needs a vast training set for better accurate results; in the field of medical image processing, the gathering of medical data is a tedious job, and, in few cases, the datasets might not be available. In all such cases, the proposed algorithm must be robust enough for accurate recognition of tumor regions from MR Images. The proposed approach can be further improvised through in cooperating weakly trained algorithms that can identify the abnormalities with a minimum training data and also self-learning algorithms would aid in enhancing the accuracy of the algorithm and reduce the computational time.

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