**An Industry Oriented Major Project Report  
 on**

**BRAIN TUMOR DETECTION USING**

**CONVOLUTIONAL NEURAL NETWOKS**

*Submitted to the*

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY - HYDERABAD**

*In partial fulfillment of the requirement for the award of the degree of*

**BACHELOR OF TECHNOLOGY**

**IN**

**COMPUTER SCIENCE AND ENGINEERING**

*BY*

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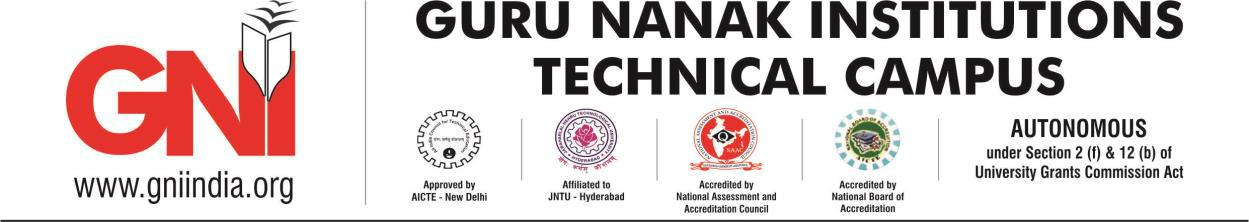


**GURU NANAK INSTITUTIONS TECHNICAL CAMPUS (AUTONOMOUS)**

**School of Engineering and Technology**

**Ibrahimpatnam, R.R District 501506**

**2019-2020**



**CERTIFICATE**

This is to certify that this project report entitled **“BRAIN TUMOR DETECTION USING CONVOLUTIONAL NEURAL NETWORKS”** by **T. VARUN** submitted in partial fulfillment of the requirements for the degree of **Bachelor of Technology** in **Computer Science and Engineering** of the **Jawaharlal Nehru Technological University Hyderabad** during the academic year 2019-2020, is a bonafide record of work carried out under our guidance and supervision.

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**PROJECT CO-ORDINATOR INTERNAL GUIDE & HOD CSE**

**Mrs. V. Swathi Mr. V. Deva Sekhar**

**EXTERNAL EXAMINER**

**ACKNOWLEDGEMENT**

We wish to express our sincere thanks to **Dr. Rishi Sayal,** Associate Director, GNITC for providing us with the conducive environment for carrying through our academic schedules and Project with ease.

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**T. VARUN (16WJ1A05V2)**

**ABSTRACT**

A human brain is centre of the nervous system; it is a collection of white mass of cells. A tumor of brain is collection of uncontrolled increasing of these cells abnormally found in different part of the brain namely Glial cells, neurons, lymphatic tissues, blood vessels, pituitary glands and other part of brain which lead to the cancer. Cancer of Brain is of two types. Benign which is not cancerous no danger at all, other one is Malignant which is cancerous tumor; it grows abnormally by multiplying the cells rapidly, which leads to the death of the person if not detected. Manually it is not so easily possible to detect and identify the tumor. Programming division method by MRI is way to detect and identify the tumor. In order to give precise output a strong segmentation method is needed.

Brain tumor identification is really challenging task in early stages of life. But now it became advanced with various machine learning and deep learning algorithms. Now a day’s issue of brain tumor automatic identification is of great interest. In Order to detect the brain tumor of a patient we consider the data of patients like MRI images of a patient’s brain. Here our problem is to identify whether tumor is present in patient’s brain or not. It is very important to detect the tumors at starting level for a healthy life of a patient. There are many literatures on detecting these kinds of brain tumors and improving the detection accuracies.

The segmentation, detection, and extraction of infected tumor area from magnetic resonance (MR) images are a primary concern but a tedious and time taking task performed by radiologists or clinical experts, and their accuracy depends on their experience only. So, the use of computer aided technology becomes very necessary to overcome these limitations.

We estimate the brain tumor severity using Convolutional Neural Network algorithm which gives us accurate results.

**KEYWORDS:**

Tumor Detection, Convolutional Neural Network, Gaussian Filters, MRI Images, Brain.

**INTRODUCTION:**

With the improvement of modern medical standards, medical imaging technology plays an increasingly important role in daily medical diagnosis and medical research. Therefore, research on medical diagnostic image data is very important. As a tumor disease with frequent occurrence and complexity, brain tumor has become a key research topic in the medical field. The diagnosis of brain tumors is usually based on imaging data analysis of brain tumor images. Accurate analysis of brain tumor images is a key step in determining a patient's condition. However, the accumulation of doctors' personal medical knowledge, differences in experience levels, and visual fatigue can affect the correct analysis of image results. Therefore, how to accurately detect brain tumor images is very important. Magnetic Resonance Imaging (MRI) can provide information on the shape, size, and position of human tissues and organs without high ionizing radiation. The images obtained are very clear and precise. MRI greatly improves the diagnostic efficiency, avoids the operation of thoracotomy or laparotomy exploration, and provides a good guide for lesion localization and surgical treatment. Brain tumor MRI uses three-dimensional multi-band imaging technology, and chest X-ray scanning, etc. Compared with 2D images, 3D multiband MRI can provide the coordinate position of the lesion area to assist the doctor to accurately locate the lesion area. In addition, MRI imaging can also obtain different structures of the same tissue using the unused development sequence. That is, a multimodal MRI image. Different modes can display different brain tumor features.

**MOTIVATION:**

A brain tumor is defined as abnormal growth of cells within the brain or central spinal canal. Some tumors can be cancerous thus they need to be detected and cured in time. The exact cause of brain tumors is not clear and neither is exact set of symptoms defined, thus, people may be suffering from it without realizing the danger. Primary brain tumors can be either malignant (contain cancer cells) or benign (do not contain cancer cells).

Brain tumor occurred when the cells were dividing and growing abnormally. It is appearing to be a solid mass when it diagnosed with diagnostic medical imaging techniques. There are two types of brain tumor which is primary brain tumor and metastatic brain tumor. Primary brain tumor is the condition when the tumor is formed in the brain and tended to stay there while the metastatic brain tumor is the tumor that is formed elsewhere in the body and spread through the brain.

The symptom having of brain tumor depends on the location, size and type of the tumor. It occurs when the tumor compressing the surrounding cells and gives out pressure. Besides, it is also occurring when the tumor blocks the fluid that flows throughout the brain. The common symptoms are having headache, nausea and vomiting, and having problem in balancing and walking. Brain tumor can be detected by the diagnostic imaging modalities such as CT scan and MRI. Both of the modalities have advantages in detecting depending on the location type and the purpose of examination needed. In this paper, we prefer to use the CT images because it is easy to examine and gives out accurate calcification and foreign mass location.

The CT image acquired from the CT machine give two-dimension cross sectional of brain. However, the image acquired did not extract the tumor from the image. Thus, the image processing is needed to determine the severity of the tumor depends on the size.

The reasons for selecting CT images upon MRI images are as follows:

1. CT is much faster than MRI, making it the study of choice in cases of trauma and other acute neurological emergencies. CT can be obtained at considerably less cost than MRI.
2. CT can be obtained at considerably less cost than MRI.
3. CT is less sensitive to patient motion during the examination.
4. The imaging can be performed much more rapidly, so CT may be easier to perform in claustrophobic or very heavy patients.
5. CT can be performed at no risk to the patient with implantable medical devices, such as cardiac pacemakers, ferromagnetic vascular clips and nerve stimulators.

The focus of this project is CT brain images’ tumor extraction and its representation in simpler form such that it is understandable by everyone. Humans tend to understand colored images better than black and white images, thus, we are using colors to make the representation simpler enough to be understood by the patient along with the medical staff. Contour plot and c-label of tumor and its boundary is programmed to give 3D visualization from 2D image using different colors for different levels of intensity. A user-friendly GUI is also created which helps medical staff to attain the above objective without getting into the code.

**AIM & OBJECTIVE – PROBLEM DESCRIPTION:**

The aim of the paper is tumor identification in brain CT images. The main reason for detection of brain tumors is to provide aid to clinical diagnosis. The aim is to provide an algorithm that guarantees the presence of a tumor by combining several procedures to provide a foolproof method of tumor detection in CT brain images. The methods utilized are filtering, contrast adjustment, negation of an image, image subtraction, erosion, dilation, threshold, and outlining of the tumor.

The focus of this project is CT brain images’ tumor extraction and its representation in simpler form such that it is understandable by everyone. Humans tend to understand colored images better than black and white images, thus, we are using colors to make the representation simpler enough to be understood by the patient along with the medical staff.

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. Aim of this paper is to define an algorithm that will result in extracted image of the tumor from the CT brain image. The resultant image will be able to provide information like size, dimension and position of the tumor, plotting contour and c-label 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. Plotting contour-f plot and c-label plot of the tumor and its boundary will give easy understanding to the medical staff because humans comprehend images better with the help of different colors for different levels of intensity, giving 3D visualization from a 2D image.

**LITERARTURE REVIEW:**

1. Paper Title: Brain Tumor Detection Based on Multimodal Information Fusion and Convolutional Neural Network.

Authors: Ming Li, Lishan Kuang, Shuhua Xu, and Zhanguo Sha

About the paper:

In this paper, a method with three-dimensional MRI brain tumor detection combining multimodal information fusion and CNN is proposed. Firstly, it is better to use the improved multimodal 3D-CNNs to obtain the three-dimensional features of brain tumor lesions under different modalities. Extract the difference information between the various modes. Secondly, in order to solve the problem that the network convergence is slow and the over-fitting is serious, the brain tumor characteristic data is normalized. Then, according to the small volume of the lesion area and the large volume of the non-focal area, a new weighted loss function is constructed to weaken the interference of the non-focal area on the detection of brain tumors, and the loss function can be improved to reduce the detection of brain tumors in non-focal areas. The experimental results show that the three evaluation indexes of dice, SN and SE are optimized respectively, and the two-dimensional brain tumor detection network and the original single-mode brain tumor detection method are compared. There has been a big improvement.

1. Paper Title: Brain Tumor Detection Using Convolutional Neural Network

Authors: Tonmoy Hossain, Fairuz Shadmani Shishir, Mohsena Ashraf, MD Abdullah Al Nasim, Faisal Muhammad Shah

About the paper:

Image segmentation plays a significant role in medical image processing as medical images have different diversities. For brain tumor segmentation, they have used MRI and CT scan images. MRI is most vastly used for brain tumor segmentation and classification. In their work, they have used Fuzzy C-Means clustering for tumor segmentation which can predict tumor cells accurately. The segmentation process was followed by classification using traditional classifiers and Convolutional Neural Network. In the traditional classifier part, they have applied and compared the results of different traditional classifiers such as K-Nearest Neighbor, Logistic Regression, Multilayer Perceptron, Naïve Bayes, Random Forest, and Support Vector Machine. Among these traditional ones, SVM gave us the highest accuracy of 92.42%. Further, for better results, they have implemented CNN which brought in the accuracy 97.87% with a split ratio of 80:20 of 217 images, i.e. 80% of training images and 20% of testing images. In the future, they have planned to work with 3D brain images, achieve more efficient brain tumor segmentation. Working with a larger dataset will be more challenging in this aspect, and they have wanted to build a dataset emphasizing the abstract with respect to their country which will accelerate the scope of their work.

1. Paper Title: Classification of brain tumor types by deep learning with convolutional neural network on magnetic resonance images using a developed web-based interface

Authors: Hasan Ucuzal, Şeyma YAŞAR, Cemil Çolak

About the paper:

The aim of this study is to develop web-based software that can classify brain tumors (glioma, meningioma, pituitary) based on high-precision T1 contrast magnetic resonance images using convolutional neural network from deep learning algorithm. Thanks to the free web-based software developed, it is believed that medical professionals and other health professionals can classify brain tumors faster and more accurately. In this aspect, the software can be used as a clinical decision support system in the classification of brain tumor types (i.e., glioma, meningioma, pituitary). According to the experimental results, all the calculated performance metrics are higher than 98% for classifying the types of brain tumors on the training dataset. Similarly, all the performance metrics are higher than 91% except for sensitivity and MCC performance metrics for meningioma brain tumor on the testing dataset. When considering the calculated performance metrics from the CNN model on the training and testing stages, the proposed model is successfully capable of classifying brain tumor types. A recent study has developed a deep learning system established on CNN for classifying brain tumors on public data sets, containing 233 and 73 patients with a total of 3064 and 516 images on T1-weighted contrast-enhanced magnetic resonance images. The developed system in the study realizes a important performance with the best total accuracy rates of 96.13% and 98.7% for the two datasets, respectively and can successfully classify for brain tumor multi-classification tasks. In another article, a new deep learning algorithm has been constructed for classifying brain tumors into grade I, grade II, grade III and grade IV on the CNN deep learning algorithm. The new deep learning algorithm consists of three stages: tumor segmentation, data augmentation and deep features extraction/classification. Experimental results in the studied paper point out that the proposed algorithm has better performance than the present methods when it is applied to the augmented and original datasets. Machine learning and deep learning algorithms have been reported to perform well in the classification and prediction of T1-weighted magnetic resonance images of brain tumors in the previous studies. However, when considering the machine learning/data mining applications of the reported studies in recent years, the selection and creation of these algorithms may require a lot of time and experience. Therefore, automatic machine learning and different modeling systems have been commonly developed in recent years. In a nutshell, the current study presents novel public web-based software for classifying the types of brain tumors based on T1-weighted MR image scans by CNN algorithm of deep learning. In the following stages, it is envisaged to develop a system that can classify data sets containing brain images of healthy individuals in addition to the images of the brain tumors of patients examined in this study.

1. Paper Title: Brain Tumor Segmentation Using Deep Learning by Type Specific Sorting of Images

Authors: Zahra Sobhaninia, Safiyeh Rezaei, Alireza Noroozi, Mehdi Ahmadi, Hamidreza Zarrabi, Nader Karimi, Ali Emami, Shadrokh Samavi

About the paper:

In this paper, they have introduced a new method for CNN to automatically segmenting the most common types of brain tumor, i.e. the Glioma, Meningioma, and Pituitary. This technique does not require preprocessing steps. The results show that the separation of images based on angles improves segmentation accuracy. The best Dice score that was obtained is 0.79. This relatively high score was obtained from segmentation of tumors in sagittal view images. Sagittal images do not contain details of other organs and tumor is more prominent than other images. The lowest Dice score in their experiments was 0.71 which is related to the images from the axial view of the head. As compared to other images, axial view contains fewer details. It is expected that by performing preprocessing on this group of images better classification of tumor pixels could be obtained and the Dice score will increase. Their proposed method may be implemented as a simple and useful tool for doctors in segmenting of brain tumor in MR images.

1. Paper Title: High-Resolution Encoder–Decoder Networks for Low-Contrast Medical Image Segmentation

Authors: Ming Sihang Zhou, Dong Nie, Ehsan Adeli , *Member, IEEE*, Jianping Yin

About the paper:

In this paper, they have proposed a high-resolution multi-scale encoder-decoder network (HMEDN) to segment medical images, especially for the challenging cases with blurry and vanishing boundaries caused by low tissue contrast. In this network, three kinds of pathways (i.e., skip connections, distilling pathways, and high-resolution pathways) were integrated to extract meaningful features that capture accurate location and semantic information. Specifically, in the distilling pathway, both U-Net structure and HED structure were utilized to capture comprehensive multi-scale information. In the high resolution pathway, the densely connected residual dilated blocks were adopted to extract location accurate semantic information for the vague boundary localization. Moreover, to further improve the boundary localization accuracy and the performance of the network on the relatively “hard” regions, they have added a contour regression task and a difficulty-guided cross entropy loss to the network. Extensive experiments indicated the superior performance and good generality of their designed network. Through the experiments, they have made several observations: (1) Skip connections, which are usually adopted in the encoder-decoder networks, are not enough for detecting the blurry and vanishing boundaries in medical images. (2) Finding a good balance between semantic feature resolution and the network complexity is an important factor for the segmentation performance, especially when small and complicated structures are being segmented in blurry images. Observing the failed samples of their algorithm, they have found that the algorithm fails in cases where the boundaries are totally invisible due to significant amounts of noise incurred by low dose, metal, and motion artifacts, and so forth. To solve these problems, in the future they have will combine their algorithm with shape-based segmentation methods and incorporate more robust shape and structural information of target organs.

**SOFTWARE REQUIREMENTS**

1. Software requirements is a field within software engineering that deals with establishing the needs of stakeholders that are to be solved by software. The IEEE standard Glossary of software engineering Technology defines a software requirement as A condition or capability needed by a user to solve a problem or achieve an objective.
2. A condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification or other formally imposed document
3. A documented representation of a condition or capability as in 1 or 2

|  |  |  |
| --- | --- | --- |
| FRONT END | : | HTML, CSS, Python, Javascript |
| BACK END | : | Python |
| OPERATING SYSTEM | : | WINDOWS 7 or above, MAC OS X |
| IDE | : | Sublime Text, BRACKETS |

**HARDWARE REQUIREMENTS**

The most common set of requirements defined by any operating system or software application is the physical computer resources, also known as hardware. A hardware requirements list is often accompanied by a hardware compatibility list (HCL), especially in case of operating systems. An HCL list tested, compatible, and sometimes incompatible hardware devices for a particular system or application.

|  |  |  |
| --- | --- | --- |
| PROCESSOR | : | Intel Core i5 |
| RAM | : | 4 GB DD RAM |
| HARD DISK | : | 128 GB or above |

**PRE-PROCCESSING:**

In the preprocessing phase, the two class of images (yes or no) is taken and feed into the CNN model and then combined and encoded into the multi-dimensional array. After that the filters are applied. The filters which are used are Guassian Filter to blur and make the images to be specific. After that those images are sent into converted into array format and then the whole data is saved as numpy file (.npy). The shuffled data is read in the array format and made into train data and test data. But for the images in both the train and test data we need to reshape the images as required for the Convolutional Neural Network Model.

**Tools Used**

1. **Noise Removal and Sharpening**

As a grayscale or colored image maybe the inputted image, the first step is to convert the given image into a grayscale image. On procuring the grayscale image, the aim then is to filter it so as to sharpen it and remove any noise, if present. In the algorithm, unsharp filtering of fspecial filter is applied in order to sharpen the image by removing the low intensity values. For noise-removal ‘Gaussian’filters are used from fspecial filters.

1. **Erosion and Dilation**

After pre-processing, next step is to estimate the background. In order to do so we make use of the basic morphological operations, erosion and dilation. More erosion [14] and less dilation will result in decrease in skull bones’ image size. To accomplish this, we will keep the eroding structural element’s radius bigger than that of dilating structural elements. The structuring element used is ‘diamond’.

1. **Negation**

The estimated background, obtained by the previous step, will contain the eroded tumor region as our aim was to remove the skull boundary and radius of structuring element was kept as such. Negative of the image can be calculated by subtracting the image from 255 which the highest value any pixel can have.

1. **Subtraction**

Subtracting background and negative of background from eroded image will result in images with and without tumors. These images will contain skull’s boundary along with the tumor region and thus will be imperfect for use.

1. **Contrast Adjustment**

In order to provide a clear and well-defined image to work upon, this operation is further applied to the result of subtracting images in previous step. This operation involves increasing the contrast of the filtered image, which is accomplished by performing contrast adjustment techniques. These contrast images will further be subtracted from dilated image.

1. **Threshold**

Next step in this algorithm is to calculate global image threshold using Otsu's method, which chooses the threshold to minimize the intra-class variance of the black and white pixels. Thus we will get a clear image of the tumor region.

1. **Boundary Detection**

In earlier times without aid of medical imaging tumors were identified manually and boundaries were drawn around it by an expert which always contained issues related to manual-error. Thus, to remove this error, the next step includes producing a clear boundary of the identified tumor using the morphological operation ‘remove’, which removes all the interior pixels, thus leaving only the boundary pixels on.

1. **Contour and C-label**

Contour is a curve along which the function has a constant value. A contour line (often just called a "contour") joins points of equal elevation (height) above a given level. These different levels are represented by different colored boundaries. Contour-f function gives a better view of the system by each level with different colors. C-label adds height labels to a 2-D contour plot, providing a better insight to the image.

**Project Model:**

The project model consists of five phases. They are: Dataset, Preprocessing, Training the Convolutional Neural Network (CNN), Prediction and Classification. In the first phase, the MRI data set is taken as the input the Deep learning model. Then it is transferred into the next phase, i.e., preprocessing. In the preprocessing phase, the two class of images (yes or no) is taken and feed into the CNN model and then combined and encoded into the multi-dimensional array. After that the filters are applied. The filters which are used are Gaussian Filter to blur and make the images to be specific. After that those images are sent into converted into array format and then the whole data is saved as Numpy file (.npy). The shuffled data is read in the array format and made into train data and test data. But for the images in both the train and test data we need to reshape the images as required for the Convolutional Neural Network Model. The Convolutional Neural Network Model is build using the “Tensorflow library” which is a Google’s Neural Network Framework. In the first layer of the model, **Conv2D** is defined which is a 32 layers Convolutional Neural Network layer with the activation function **relu** which is a short form for Rectified Linear. The activation function is used to activate the Neural Network layer to work as per the given instructions. Next, **MaxPooling2D** is for the pooling of image. Pooling is the process of compression of images in the smaller format to for the easy identification of the specification in the image. In the next lines the same **Conv2D** is repeated twice with 64 layers of Neurons. At last the weights of the neural network layer are reduced by 25% using Dropout method. In the next line the total Convolutional model is flatten and passed through 3 layers of Sequential Dense layers with 512, 128, 128 neurons respectively. At last the final line is used for the classification which is activated by **SoftMax** activation function. The whole model is compiled using Adam Optimizer and the metrics of loss are evaluated using **Sparse cross entropy** method. The whole model is fitted by compiling it with 15 iterations using train dataset and test dataset. Finally, the model is saved as **BrainTumorDetection-Tensorflow.model.** The summary of the training is printed using summary function. And the model accuracy is evaluated and the test accuracy is printed. The training accuracy is plotted using **matplotlib** library which is a predefined plotting library.

**Prediction Model:**

In the prediction phase a UI is created using the **Python CGI** package. Using the UI, the normal user can interact with the model and upload their details and classify using their MRI whether they have Brain tumor or not. In the prediction model, there are three phases. First phase is the Uploading of MRI test image using the UI. Then the trained CNN model will classify the given image as Yes or No or Benign or Malignant, which means whether the tumor is identified in the given image or not.

The accuracy of the model was 99.7% which was achieved after 15 epochs or iterations in the CNN model. The graph of the accuracy and loss is shown in the Figure-9 which was plotted using the Matplotlib package in python.