DEEP LEANING BASED BRAIN TUMOR DETECTION

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ABSTRACT

A brain tumor is a disease caused due to the growth of abnormal cells in the brain. There aretwo main categories of brain tumor, they are non- cancerous (benign) brain tumor and cancerous(malignant) brain tumor. Survival rate of a tumor prone patient is difficult to predict becausebrain tumor[6-10] is not common and are different types. As per the cancer research by United Kingdom, around 15 out of every 100 people with brain cancercan be able to survive for ten or more years after being diagnosed. Treatment for brain tumor depends on various factors like: the type of tumor, how abnormal the cells are and where it is in the brain etc. With the growth of Artificial Intelligence,Deep learning models[3] are used to diagnose the braintumor by taking the images of magnetic resonance imaging. Magnetic Resonances Imaging (MRI[4-5]) is a type of scanning method that uses strong magnetic fields and radio waves to produce detailed images ofthe inner body. The research work carried out uses Deep learning models like convolutional neural network (CNN) model and VGG-16 architecture(built from scratch) to detect the tumor region in the scanned brain images. We have considered Brain MRI[4-5] images of 253 patients, out of which 155 MRI images are timorous and 98 of them are non- timorous. The paper presents a comparative study of the outcomes of CNN model[4] and VGG-16 architecture used.

Keywords: Brain Tumor, CNN, Machine Learning.

1.INTRODUCTION

Machine learning algorithms[3] have thepotential to be invested deeply in all Fields of medicine, from drug discovery to clinical decision making, significantly altering the way medicine is practiced. The success of machine learning algorithms at computer vision tasks in recent years comes at an opportune time when medical records are increasingly digitalized. It takes years and great financial cost to train a qualified radiologist, and some health-care systems

outsource radiology reporting to lower-cost countries such as India via tele-radiology. A delayed or erroneous diagnosiscauses harm to the patient. Therefore, it is ideal for medical image analysis to be carried out by an automated, accurate and efficient machine learning algorithm.

Medical image[1-3] analysis is an active field of research for machine learning, partly because the data isrelatively structured and labelled, and it is likely that this will be the area where patients interact with functioning, practical artificial intelligence systems. Secondly, it provides a testbed for human-AI interaction, of how receptive patients will be towards health altering choices being made, or assisted by a non-human actor. A brain tumor is defined as abnormal growth of cells within the brain or

ISSN: 2278-4632
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central spinal canal. Some tumors can be cancerous thus they need to be detected and cured intime. 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 appeared 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 tumour 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 2 on the locationtype and the purpose of examination needed. 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[4-5] are as follows:

1. CT is much faster than MRI, making it the studyof choice in cases of trauma and other acute neurological emergencies. CT can be obtained at considerably less cost than MRI[4-5].

2. CT can be obtained at considerably less cost thanMRI.

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 nervestimulators.

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 coloured images better than black and white images; thus, we are using colours 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 colours 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.

Problem Definition:

The driving force of this project is to create a transparent environment where medical staff and patient can work in complete cooperation to achieve better results. This transparent environment will help the patient to feel secure as they will understand the treatment-process choice, which in turn will help the medical staff to handle the situation in a calm order giving them more time to think and work. The methods utilized are filtering, contrast adjustment, negation of an image, image subtraction, erosion, dilation, threshold, and outlining of the tumor.

Objective of Project

6. 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 fool proof method of tumor detection in CT brain 3 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[8] and its representation in simpler form such that it is understandable by everyone. Humans tend to understand coloured images better than black and white images; thus, we are using colours 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

n 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.

2. Literature Survey

Introduction:

The CT image acquired from the CT machine give two-dimension cross sectional

ISSN: 2278-4632
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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 thetumor depends on the size.

1. Trends in electronic health record system use among office-based physicians: United states Abstract:

The National Ambulatory Medical Care Survey (NAMCS)[4-5] is based on a national probabilitysample of non federal office-based physicians who see patients in an office setting. Prior to 2008, data on physician characteristics were collected through in-person interviews with physicians

2. Use of diagnostic imaging studies and associated radiation exposure for patients enrolled in large integrated health care systems.

3.A survey on deep learning in medical imageanalysis.

Deep learning algorithms in particular known as convolutional networks, have rapidly become a methodology of choice for analysing medicalimages. This paper reviews the major deep learningconcepts pertinent to medical image analysis and summarizes over 300 contributions to the field, mostof which appeared in the last year. We survey the useof deep learning for image classification, object detection, segmentation, registration, and other tasks. Concise overviews are provided of studies per application area: neuro, retinal, pulmonary, digital pathology, breast, cardiac, abdominal, musculoskeletal. We end with a summary of the current state-of-the art, a critical discussion of open challenges and directions for future research.

4.A logical calculus of the ideas immanent in nervous activity.

Because of the “all-or-none” character of nervous activity, neural events and the relations among them can be treated by means of propositional logic. It is found that the behaviour ofevery net can be described in these terms, with the addition of more complicated logical means for netscontaining circles; and that for any logical expression satisfying certain conditions, one canfind a net behaving in the fashion it describes. It is shown that many particular choices among possible neurophysiological assumptions are equivalent, in the sense that for every net behaving under one assumption, there exists another net which behaves under the other and gives the same results, althoughperhaps not in the same time. Various applications of the calculus are discussed.

3. EXISTING SYSTEM

In the existing solution of extraction of brain tumour from CT scan images tumour part is detected from the CT scan of the brain. The proposed solution also does the same thing, inform the user about details of tumour[6-10] using basic image processing techniques. The

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methods include noise removal and sharpening of the image along with basic morphological functions, erosion and dilation, to obtain the background. Subtraction of backgroundand its negative from different sets of images resultsin extracted tumour image.

Drawbacks in Existing System

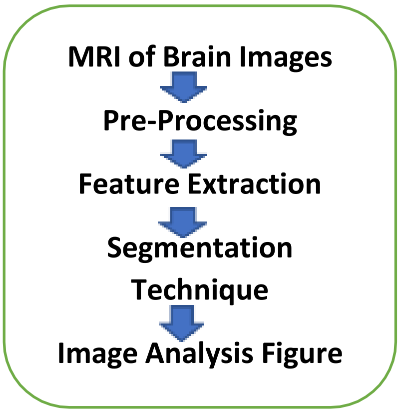
The difference in the proposed solution with existing solution is plotting contour and c-label of the tumor and its boundary which provides us with information related to the tumor that can helpin a better visualization in diagnosing cases. This process helps in identifying the size, shape and position of the tumor. It helps the medical staff as well as the patient to understand the seriousness of the tumor with the help of different colour- labelling for different levels of elevation.

4. PROPOSED SYSTEM

Neural network layer representation Currently, CNNs are the most researched

machine learning algorithms in medical image analysis. The reason for this is that CNNs preserve spatial relationships when altering input images. As mentioned, spatial relationships are of crucial importance in radiology, for example, in how the edge of a bone joins with muscle, or where normal lung tissue interfaces with cancerous tissue. CNN takes an input image of raw pixels, and transforms it via Convolutional Layers, Recited Linear Unit (RELU) Layers and Pooling Layers. This feeds into a Fully Connected Layer which assigns class scores or probabilities, thus classifying the input into the class with the highest probability.

The algorithm is a set of image



processing fundamental procedures. A set of noise-removal functions accompanied with morphological operations that result in clear image of tumor after passing through high pass filter is the basic idea behind the proposed algorithm. The set of morphological operations used will decide the clarity and quality of the tumor image. A GUI is created in the Python offering the proposed application of extracting the tumor from selected brain image and its visualization using contour plot. Without having to deal with the code, medical staff can select the CT image and study the extracted tumor along with its boundary from contour and c- label options. The GUI also contains options for zoom-in, zoom-out, data cursor for co-ordinates, and prints the selected image. In this project,

ISSN: 2278-4632
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we have described our objective in two parts, the first half deals with detection of brain tumor that is the presence of the tumor in the provided MRI. The other part that is the second part contains the classification of the tumor. Here, we will analyze the MRI images which will conclude the stage of the tumor as benign or malignant. In general, the diagram for our process. The input images will undergo various stages which can be summarized.

TECHNOLOGIES REQUIRED FOR IMPLEMENTATION

Software Environment

Python is a general-purpose interpreted, interactive, object-oriented, and high-level programming language. An interpreted language, Python has a design philosophy that emphasizes code readability (notably using whitespace indentation to delimit code blocks rather than curly brackets or keywords), and a syntax that allows programmers to express concepts in fewer lines of code than might be used in languages such as C++ or Java. C Python is managed by the non-profit Python Software Foundation.

Approaches

Correlation is a measure of association between two variables that are not designated as either dependent or independent. **Regression** at a basic level is used to examine the relationship between one dependent and one independent variable. Because regression statistics can be used toanticipate the dependent variable when the independent variable is known, regression enables prediction capabilities.

k-nearest neighbour

The k-nearest neighbour algorithm is a pattern recognition model that can be used for classification as well as regression. Often abbreviated as k-NN, the k in k-nearest neighbor[4] is a positive integer, which is typically small. In either classification or regression, the input will consist ofthe k closest training examples within a space. We will focus on k-NN classification. In this method, theoutput is class membership. This will assign a new object to the class most common among its k nearestneighbours. In the case of k = 1, the object is assigned to the class of the single nearest neighbour.

Introduction to Deep Learning

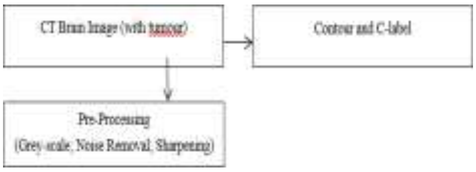
Deep learning[3] is a particular kind of machine learning that achieves great power and flexibility by learning to represent the world as a nested hierarchy of concepts, with each conceptdefined in relation to simpler concepts, and more abstract representations computed in terms of less abstract ones

5. SYSTEM DESIGN

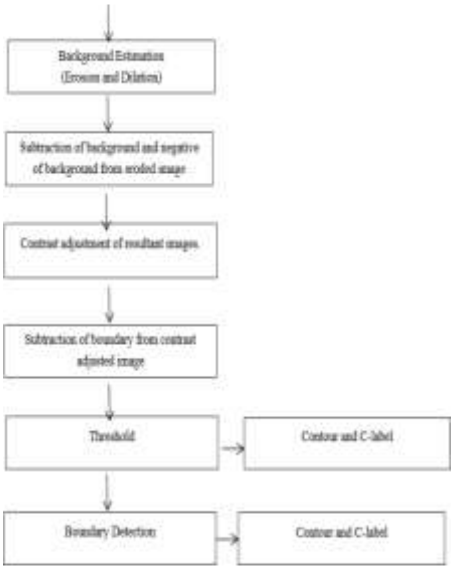
Considered Design Constraints:

1. User Interface Constraints Using this

system is fairly simple and intuitive. A user



familiar with basic computer operability skills should be able to understand all functionality provided by the system.



2. Hardware Constraints The system should work on most home desktop and laptop computers and can be extended to mobile phone apps.

3. Software Constraints The system is designed to run on Python having GUIDE. 37

4. Communications Constraints System must have access to the images of CT scan for brain tumour. Data Management Constraints System shall be able to interface with other components according to their specifications. 4.3.6 Operational Constraints The system is not limited to any Operating System. It works in equally good in Windows, Mac and LINUX.

System Architecture

Requirement Specification:

Functional Requirements

▪ Graphical User interface with the User. Software Requirements For developing the application, the following are the Software Requirements: Python Operating Systems supported, Windows Technologies and Languages used to develop Python Hardware Requirements For developing the application, the following are the Hardware Requirements:

▪ Processor: Pentium IV or higher 35

▪ RAM: 2 GB

▪ Space on Hard Disk: 5GB

System Interface Description

System Interface Description

In this model the data and functionality are arrived from inside the system. This model view models the static structures.

Key Functions:

Modules: The project is carried out based on the following modules listed:

Tools Used

A. NOISE REMOVAL AND SHARPENING

As a grayscale or coloured image[1-2] maybe the inputted image, the first step is to convert the given image into a grayscale image. On

ISSN: 2278-4632
Vol-12 Issue-09 No.02 September 2022

procuring the grayscale image, the aim then is to filter it so as to sharpen itand remove any noise, if present. In the algorithm, unsharp filtering of special filter is applied in orderto sharpen the image by removing the low intensity values. For noise-removal 'Gaussian' filters are used from special filters.

B.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 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'.

C. NEGATION

The estimated background, obtained by the previous step, will contain the eroded tumor region a sour 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.

D. SUBSTRACTION

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.

E.CONTRAST ADJUSTMENT

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.

F.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.

G.BOUMDARY DETECTION

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.

H.CONTOUR AND C-LABEL

A contour line (often just called "contour") joins points of equal elevation (height) above a given level. These different levels are represented by different coloured boundaries. Contour-f function gives a better view of the system byeach level with differentcolours. C-label adds height labels to a 2-D contour plot, providing a better insight to the image.

ISSN: 2278-4632
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6. RESULTS & DISCUSSION

Results:

This paper focuses upon the detection and visualization of a tumor in the brain from CTimages[4-5]. By developing the proposed architecture, the demarcation of the tumor in the CT image is obtained. The following results showcase the outputs received after each step in the algorithm. These basic pre-processing transformations include:

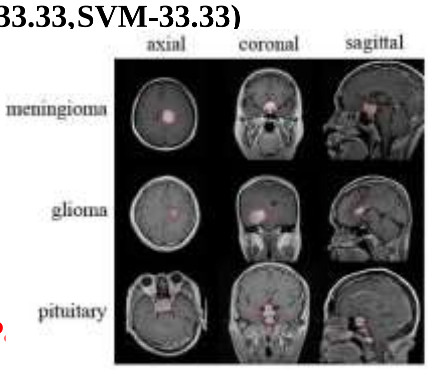
1. Changing the image to greyscale, as we need to find contour of the final image[1-3] which works ongreyscale images.
2. Applying low pass filter, to remove any noise, if present, in the image.
3. Applying high pass filter, to obtain sharpened image with clear-defined boundaries.

Fig : Detection of stages in braintumor.

Accuracy:

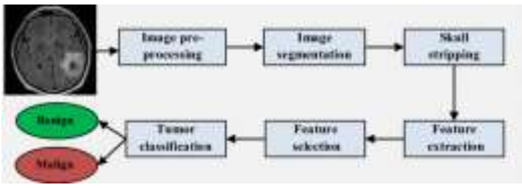
Deep Learning-CNN-95.6

Machine Learning (logistic regression-33.33,SVM-33.33)



7. CONCLUSION

A recurring theme in machine learning[3] isthe limit imposed by the lack of labelled datasets, which hampers training and task performance. Conversely, it is acknowledged that more data improves performance, as Sun et al. shows using an internal Google dataset of 300 million images. In general computer vision tasks, attemptshave been made to circumvent limited data by using architecture combinations, or hyperparameter optimization. Data or class imbalance in the training set is also a significant issue in medical image analysis. This refersto the number of images[1-3] in the training data being skewed towards normal and non-pathological images. Rare diseases are an extreme example of this and can be missed



without adequate training examples. This data imbalance effect can be ameliorated by using data augmentation to generate more training images of rare or abnormal data, though there is risk of overfitting. Aside from data-level strategies, algorithmic modification strategies and cost sensitive learning have also been studied. The

ISSN: 2278-4632
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proposed algorithm[3] is inputted with gray scale images of brain that contain tumor/s. The image is processed through various stages of morphological operations like filtering, contra adjustment, erosion, dilation etc. through Python programming. Hence, the tumor is outlined in the original image and clearly demarcated. Contour plot and c-label plot is created to provide 3D visualization from the 2D image. A GUI isalso developed which enables the above application with a user-friendly interface. Possible extension of the presented work could use more features. Theapplication can be extended to accessibility and usability through mobile phones Accuracy of brain tumor detection using CNN model is 93% and using VGG-16 is 86% for MRI images[4-5]. Machine learning algorithms have surpassed human performancein image recognition tasks , and it is likely that they will perform better than humans in medical image analysis as well. Indeed, some of the papers in this review report that dermatologistsand radiologists have already been bested by machine learning. Yet the question regarding legal and moral culpability arises when a patient is misdiagnosed, or suffers morbidity as a result of AI or AI-assisted medical management. This is accentuated by our inability to fully explain how the black box of machine algorithms work.

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Fig 7.1: Types of brain tumor viewn fromdifferent Angles.

S.No	Techniques	Accuracy(%)	Efficiency(%)
1	Conditional Random Field (CRF)	89	87.5
2	Support Vector Machine (SVM)	84.5	90.3
3	Genetic Algorithm (GA)	83.64	84.78
4	Convolutinal Neural Network (CNN)	91	92.7

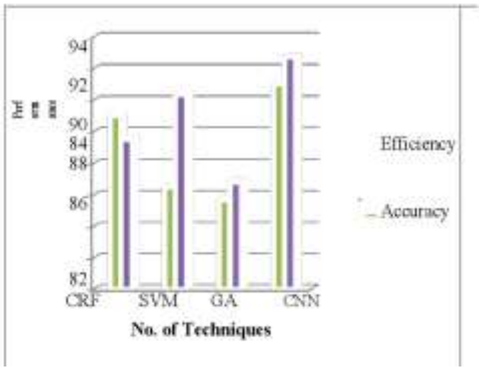

Table 7.2: Comparision of accuracy of different models