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BRAIN TUMOUR PREDICTION USING CONVOLUTIONAL NEURAL NETWORK

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ABSTRACT : The brain tumours, are the most common and aggressive disease, leading to a very short life expectancy in their highest grades. Brain tumours have high diversity in appearance and there is a similarity between tumour and normal tissue. Magnetic resonance imaging may be a medicative procedure, typically adopted by the medical specialist for illustration of inner structure with no surgery. We proposed a method to extract brain tumour from 2D Magnetic Resonance brain Images (MRI). Our projected methodology features a larger accuracy than different existent strategies for classifying tumour kind to be either as Malignant or Benign. Here we projected automatic brain tumour detection by using Convolutional Neutral Network (CNN) classification. This could effectively locate tumour lesions, and better results were obtained in correlation coefficient, sensitivity and specificity. Compared with 2D detection network, this detection accuracyis significantly improved.

KEY WORDS: Image Segmentation, Support Vector Machine ,MRI.

I. INTRODUCTION

Brain tumour is one of the vital organs in the human body, which consists of billions of cells. The abnormal group of cell is formed from the uncontrolled division of cells, which is also called as tumour. Brain tumour are divided into two types such low grades and high grades tumour. Low grades brain tumour is called as benign. Similarly, the high grades tumour is also called as malignant. Benign tumour is not cancerous tumour. Hence it doesn't spread other parts of the brains. However the malignant tumour is a cancerous tumour. Soit spreads rapidly with

indefinite boundaries to other region of the body easily. It leads to immediate death. Brain MRI image is mainly used to detect the tumour and tumour progress modelling process. This information is mainly used for tumour prediction and treatment processes. MRI image gives more information about given medical image than the CT or ultrasound image. MRI image provides detailed information about brain structure and anomaly prediction in brain tissue. Actually, Scholars offered unlike automated methods for brain tumours finding and type catalogue using brain MRI images from the time when it became possible to scan and freight medical images to the computer. Conversely, The Convolutional Neural Network (CNN) is a powerful method for image recognition and prediction. However, CNN is mostly used for brain tumour segmentation, classification, and prediction of survival time for patients and it simply involve analysing features derived from the image to perform tasks such as segmenting tumours. Segmented images can be further processed to predict clinical sequelae such as survival and response to therapy and also machine learning and image processing algorithms are used in the Prediction process. When these algorithms are applied on the MRI images the prediction of brain tumour is done very fast and a higher accuracy helps in providing the treatment to the patients.

II .LITERATURE SURVEY

1.A CNN based Approach for the Detection ofBrain Tumor Using MRI Scans

Many researchers have discussed the importance of image processing in bio- medical in multiple ways which include the processing of images of X-rays, CT scans and MRI to detect the malformation and irregularities in the human body. It has been medically proven that MRI imaging is less harmful than other imaging techniques used because it prevents the body from the exposure of harmful radiations but before analyzing any image, we need to perform a complicated task of pre- processing the images. Image pre-processing is a gradual process where one step leads to another step. It involves step like noise reduction, image enhancement, image contrasting and when it comes down to medical domain involving detection of brain tumour from an MRI scan, removing the imprints of the skull from the image becomes a prime procedure [4]. The next step that would follow is converting the image into grey scaled image, where the pixels of the image only shows intensity without color but even after this step the noise in the image is still present which needs to be eradicated before further processing. The noise in the image is removed by using filtering techniques.

Filtering: It is a technique used to enhance a picture by highlight some features while eliminating other features that do not promote any information gain in a particular study. It involves steps like noise reduction, smoothing, sharpening and edge reduction. The most frequently used filter is median filter which is used for impulsive noise and speckle noise and this technique has an edge over other techniques because of it's ability to preserve the edges of the image without cropping the signal. In [2] and

[3] researchers have used median filter to remove the noise that are by default present in an MRI but in some cases [5][6] Gaussian filters based on the principle of convolution is also used to minimize the noise in the image and blur the image by blurring the edges and reducing the contrast. The advantage of using a Gaussian filteris that it works faster than other filters.

Segmentation: After successful removal of noise from an image, the next process that follows is segmentation in which an image is broken down into pixels. ***This helps in easy analysis of the image to deduce a meaningful observation from it.*** After the grouping of pixels, each segment of pixel shares some common features. The paper by Amina et al.

[5] uses K-means clustering for segmentation. In this method images is segmented to multiple clusters on basis of the nearest mean. Veer et al.

[7] in her research used thresholding for segmentation. In thresholding if the value of intensity of a pixel is significant than some

predefined constant then it turns the pixel to black and if the value of intensity of pixel is less than the predefined value then it makes the pixel white. The algorithm which assumes pixels values as a local topography (elevation) is watershed algorithm. The algorithm floods basins from the markers, until basins attributed to different markers meet on watershed lines. In most of the cases, we chose markers as local minima of the image, from which basins are flooded.

Post Segmentation: Till segmentation the motto of the process remains same, but the further process diversifies into different kind of classification i.e. classifying the image as a normal or an abnormal MRI and then the succeeding research progressed to detect the size and location of abnormalities in MRI (here, tumour). Then researchers added a fresh step to the existing work by classifying the type of tumour into two types namely Malignant (cancerous tumour) and Benign (noncancerous tumour). Once the segmentation phase is successfully carried out many optimization techniques are applied to improve the result obtained. The first step towards this field of research is detecting any kind of anomaly in a brain, [8] used SVM classification for classifying the image into two types normal MRI and abnormal MRI. [9] detected the of tumour, skull, gray matter and white matter using morphological operations which compares the pixel value of input and output image to get the size of the required part and using manual segmentation she has calculated the area of the tumour which gives the size of the tumour despite the presence of other components of brain. For classification, [5] used the algorithm of SVM family which includes Linear, Cubic and Gaussian kernel functions. This algorithm follows the principle of drawing a hyper plane by maximizing the margin between the classes by using support. ***Three types of kernel functions are used to improve the accuracy of result and using SVM classifier he has identified the affected area as well as training his model to predict the grade of the tumour.***

[7] extended the further classification of tumour into two types –primary tumour and secondary tumour. Primary tumours are those tumours which originate in brain. They are divided into two subtypes: Malignant and Benign whereas secondary tumours are those tumours which originate in another part of the body and spreads to brain eventually. ***For classification of primary tumour she used Artificial Neural Network (ANN).*** ANN is composed of many nodes. Each node takes a single input performs an operation on it and passes it another layer of nodes and at output layer each node has a node value. It basically learns using feedback. The advantage of using ANN over other algorithms is that it can handle more variation than any traditional algorithm.

2. "Convolutional Neural Network based Classification of Brain Tumors images"Abhishta Bhandari, JarradKoppen, and Marc AgzarianPublished online 2020 Jun 8. doi: 10.1186/s13244-020-00869-4

Authors : Jayashree Shedbalkar , Dr. K.Prabhushetty

In order to know the state-of-the-art methods in the related study, following are the gist of papers.

(Rehman A et.al, 2020) have **worked proposed a method to detect brain tumors and their classification.** The selected features are verified by the feed-forward neural network for final isolation. The three BraTS data sets for 2015, 2017, and 2018 are used for research, validation, and achieve accuracy of 98.32, 96.97, and 92.67%, respectively.

(Thillaikkarasi R et.al, 2019) **have worked on in-depth learning algorithm (kernel-based CNN) with M-SVM introduction to identify tumor automatically and efficiently**. Image segmentation is done using M-SVM according with selected features. From an MRI scan, the tumor is isolated with the help of a kernel-

based CNN-based method. The experimental results of the proposed method indicate that the method used may enable the brain tumor separation to reach approximately 84% accuracy in comparison with existing algorithms.

(Zhang M etal, 2020) have **developed a methodology for detecting brain metastasis through MRI images**. A total of 361 patients from 121 patients are used to train and test with fast region-based network with a convolutional neural network (Faster R-CNN).
270 scans of 73 patients were used for training;
488 planes are used in 91 scans of 48 test patients. Examination of data captured in MRI brain showed 96% sensitivity and 20 false metastases by scans. The results showed 87.1% sensitivity and 0.24 false metastases per unit.

3. Brain Tumor Detection Using Convolutional Neural Network Tonmoy Hossain1* , Fairuz Shadmani Shishir2@ , Mohsena Ashraf3# MD Abdullah Al Nasim4&, Faisal Muhammad Shah5

-Devkota et al established the whole segmentation process based on Mathematical Morphological Operations and spatial FCM algorithm which improves the computation time, but the proposed solution has not been tested up to the evaluation stage and outcomes as- Detects cancer with 92% and classifier has an accuracy of 86.6%.

-Yantao et al resembled Histogram based segmentation technique. Regarding the brain tumour segmentation task as a three- class (tumour including necrosis and tumour, and normal tissue) classification problem regarding two modalities FLAIR and T1. The abnormal regions were detected by using a region-based active contour model on FLAIR modality. The tumour tissues were distinguished in the abnormal regions based on the contrast enhancement T1 modality by the k-means method and accomplished a Dice coefficient and sensitivity of 73.6% and 90.3% respectively.

-Badran et al adopted the canny edge detection model accumulated with Adaptive thresholding to extract the ROI. The dataset contained 102 images. Images were first pre processed, then for two sets of a neural network, for the first set canny edge detection was applied, and for the second set, adaptive thresholding was applied. The segmented image is then represented by a level number and characteristics features are extracted by the Harris method. Then two neural network is employed, first for the detection of healthy or tumor containing the brain and the second one is for detecting tumor type. Depicting the outcomes and comparing these two models, the canny edge detection method showed better results in terms of accuracy.

-Pei et al. proposed a technique which utilizes tumour growth patterns as novel features to improve texture based tumour segmentation in longitudinal MRI. Label maps are being used to obtain tumour growth modelling and predict cell density after extracting textures (e.g., fractal, and mBm) and intensity features. Performance of the model reflected as the Mean DSC with tumour cell density- LOO: 0.819302 and 3- Folder: 0.82122.

-Dina et al. introduced a model based on the Probabilistic Neural Network model related to Learning Vector Quantization. The model was evaluated on 64 MRI images, among which 18 MRI images were used as the test set, and the rest was used as a training set. The Gaussian filter smoothed the images. 79% of the processing time was reduced by the modified PNN method. A Probabilistic Neural Network based segmentation technique implemented by Othman et al. Principal Component Analysis (PCA) was used for feature extraction and also to reduce the large dimensionality of the data. The MRI images are converted into matrices, and then Probabilistic Neural Network is used for classification. Finally, performance analysis is done. The training dataset

contained 20 subjects, and the test dataset included 15 subjects. Based on the spread value, accuracy ranged from 73% to 100%.

-Concentrating on Region based Fuzzy Clustering and deformable model, Rajendran et al. accomplished 95.3% and 82.1% of ASM and Jaccard Index based on Enhanced Probabilistic Fuzzy C-Means model with some morphologicaloperations.

-Zahra et al. performed with Link Net network for tumour segmentation. Initially, they used a single Link net network and sent all training seven datasets to that network for segmentation. They did not consider the view angle of the images and introduced a method for CNN to automatically segment the most common types of a brain tumour which do not require pre processing steps. Dice score of
0.73 is achieved for a single network, and 0.79 is obtained for multiple systems.

4. Brain Tumor Detection Using Convolutional Neural Network Khan Benazir Parveen1 , Veena G. S.2 , Dr. Divakar Harekal

-Sethuram Rao et al discussed about different approaches for brain tumour segmentation and classification. Firstly, manual segmentation is discussed with help of multidisciplinary experts such as technologists, radiologists, pathologists etc. But getting accurate result is very difficult due to poor eye coordination, low tissue contrast. Result may vary from expert to expert and it is time consuming as well. Among the automatic detection techniques k-means clustering is discussed which is used for unsupervised dataset. It can characterize the regions properly but it will not be useful if the images are non-uniform, noisy. Fuzzy clustering can perform better but it is time consuming. Thresholding is another method discussed here which performs well for images with homogeneous intensity. But it does not consider the correlation between pixels because of noise present in images. Support vector machine is another technique which is quite good for analysis and then classification but it takes a lot of time for training and memory space as well. There are so many methods which have been tried but still there is no single method that has been adopted universally.

-Aby Elsa Babu et al discussed about few methods for detecting brain tumour in their paper. They compared the methods. The paper compares the methods Active Contour, Watershed Method, Thresholding and Bilateral Symmetry. They concluded Bilateral Symmetry as an efficient technique among these techniques. In this technique the image is divided symmetrically and then looks for if there is any unsymmetrical edge in image or not.

III. PROPOSED SYSTEM

We proposed a method to extract brain tumor from 2D Magnetic Resonance brain Images (MRI). Our projected methodology features a larger accuracy than different existent strategies for classifying tumor kind to be either as Malignant or Benign. Here we projected automatic brain tumor detection by using Convolutional Neutral Network (CNN) classification.

It consists of three modules,

1. Preprocessing
2. Segmentation
3. Tumour Detection

1. PREPROCESSING

The aim of pre-processing is **to improve the quality of the image so that we can analyze it in a better way**. By preprocessing we can suppress undesired distortions and enhance some features which are necessary for the

particular application we are working for. Those features

might vary for different applications.

(I)NOISE REDUCTION :

A filter is basically an algorithm for modifying a pixel value, over original value of the pixel and the values of the pixels surrounding it. There are literally hundreds of types of filters that are used in image processing. Among all the filtering techniques, common ones are:

- **Gaussian Filter or Gaussian smoothing**

  Blurring an image using Gaussian function can be known as Gaussian Filter or Gaussian Smoothing. It is used to reduce image noise andreduce details.

- **Mean Filter**

  Mean filtering is a method of 'smoothing' images by reducing the amount of intensity variation between neighboring pixels. The average filter works by moving through the image pixel by pixel, replacing each value with the average value of neighboring pixels, including itself.

- **Median Filter**

  The median filter is the filtering technique used for noise removal from images and signals. It preserve the edges during noise removal.

  It is one of the method to remove noise is by convolving the original image with a mask that represents a low-pass filter or smoothing operation. For example, the Gaussian mask comprises elements determined by a Gaussian function. This convolution brings the value of each pixel into closer harmony with the values ofits neighbours.

Experimental view :

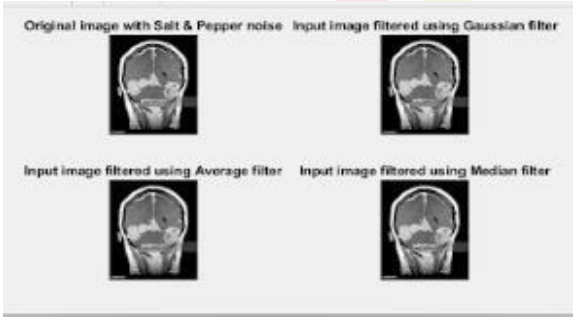


Fig 1.Noise reduction

2. SEGMENTATION

(I) IMAGE FILTER :

Image filter is the first process in brain tumour prediction. The filtering is used to remove the noise from brain tumour image. Segmentation is used to segment and divide the region . The algorithm is based on filtering of brain images which is used for removing the noise over an image and segmented with filtering images. there three type of image filter are used in this process: average filter, Gaussian filter, median filter. gaussian filter involves in this process it is. In electronics and signal processing, a gaussian filter is a filter whose impulse response is a gaussian function then median filter is a non- linear method used to eliminate noise from the MRI brain images. And it is especially effective for eradicate salt and pepper noise. The median filter works by scrolling the pixel of the image with a pixel, replacing each value with the median value of the neighboring pixels. The algorithm is based on filtering of brain images which is used for removing the noise over an image and segmented with filtering images. there three type of image filter are used in this process: average filter, Gaussian filter, median filter. gaussian filter involves in this process it is. In electronics and signal processing, a gaussian filter is a filter whose impulse response is a gaussian function then median filter is a non- linear method used to eliminate noise from the MRI brain images. And it is especially effective for eradicate salt and pepper noise. The median filter works by scrolling the pixel of the image with a pixel, replacing each value with the median value of the neighboring pixels.

Image filter is a technique through which size, colors, shading and other characteristics of an image are altered. Image filter is used to transform the image using different graphical editing techniques.

Experimental view :

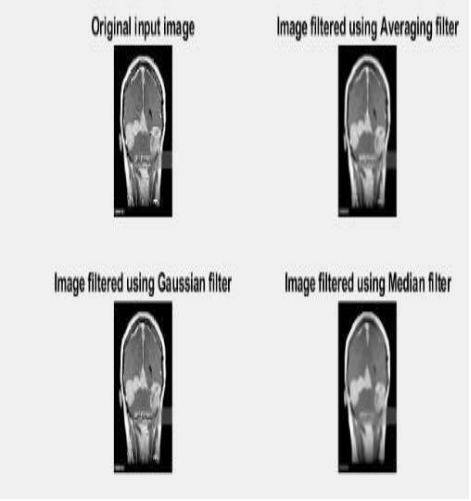


Fig 2.image filter (II)RGB TOGRAY

SCALE IMAGE :

A grayscale image is simply one in which the only colours are shades of gray. The reason for differentiating such images from any other sort of colour image is that less information needs to be provided for each pixel.

It is a one layer image from 0-255 whereas the RGB have three different layer image. So that is a reason we prefer grey scale image instead of RGB.

It converts the true colour image RGB to the grayscale image I. The rgb2gray function converts RGB images to grayscale by eliminating the hue and saturation information while retaining the luminance.

To store a single colour pixel of an RGB colour image we will need 8*3 = 24 bits (8 bit for each colour component), but when we convert an RGB image to grayscale image, only 8 bit is required to store a single pixel of the image. So we will need 33 % less memory to store grayscale image than to store an RGB image.

Grayscale images are much easier to work within a variety of task like In many morphological operation and image segmentation problem, it is easier to work with single layered image (Grayscale image) than a three-layered image (RGB colour image).It is also easier to distinguish features of an image when we deal with a single layered image.

Experimental view :

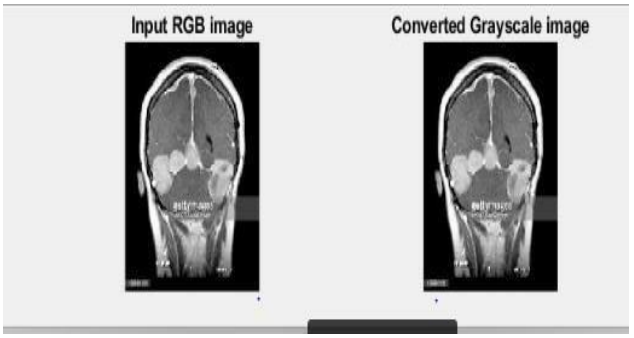


Fig 3.Converted gray scale image

HSV FILTER :

The input RGB picture change is done to the HSV shading space. The RGB display incorporates the three essential shading segments i.e. Red, Green, and Blue. The components of the HSV shading space incorporate the Hue, Saturation, and Value (intensity). Here, every component is disconnected from each other. Consequently, the HSV shading space is favoured more in picture preparing than the RGB shading model. The components of HSV are clarified in the accompanying areas. The main objective

of RGB to HSV conversion corresponds to Grey and White maters of the brain. Hue refers to the likeness of pure colour. Saturation describes the whiteness of the colour. The Value which is also known as lightness or intensity describes how the dark the colour is. We are going to extract Vvalue from HSV components.

Experimental view :Image1 :

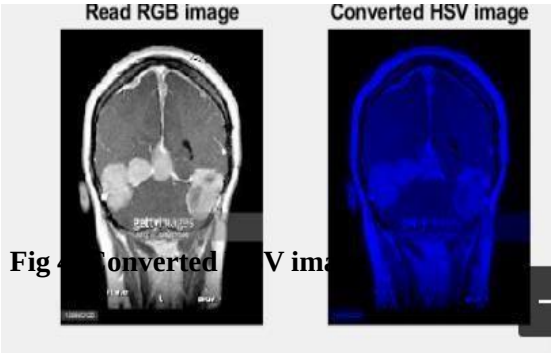
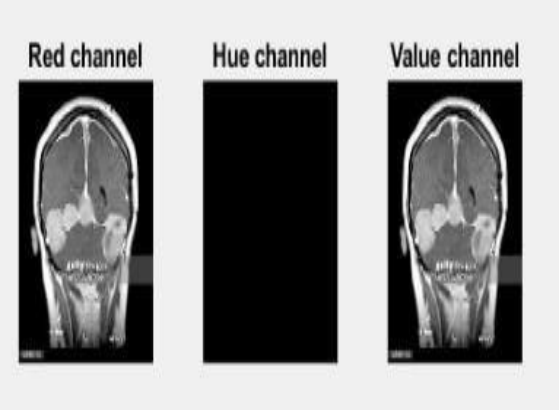


Fig 4. Converted HSV ima

Image2 :



(III) EDGE DETECTION :

Edge detection is used to identify points in a digital image with discontinuities, simply to say, sharp changes in the image brightness. These points where the image brightness varies sharply are called the edges (or boundaries) of the image. Edge detection allows users to observe the features of an image for a significant change in the gray level. This texture indicating the end of one region in the image and the beginning of another. It reduces the amount of data in an image and preserves the structural properties of an image.

Experimental view :

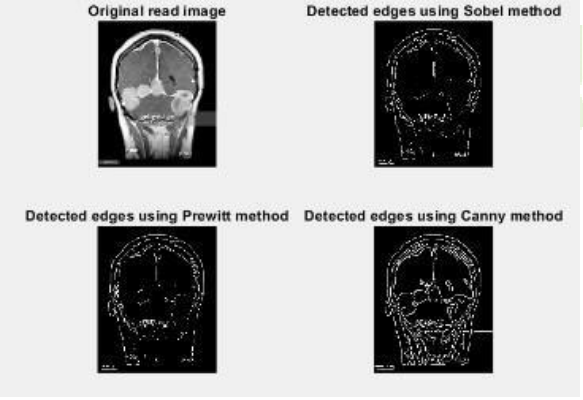


Fig 5.Edge Detection

(IV) EDGE PRESERVING FILTER :

Edge preserving filter measures the ability to maintain details of the image. It is used for noise removal from images and signals. Median filter is very crucial in the image processing field as it is well known for the preservation of edges during noise removal.

A common technique for removing noise from images is by blur-ring them with a weighted mean or a Gaussian filter. Through these processes noise reduction is achieved, but unfortunately, valuable information is lost and the details of object boundaries are deformed. A solution to this problem, especially for document images, is the use of an edge preserving smoothing technique (adaptive mean filter) where the amount of blurring for each pixel is determined after gathering local information in a specified neighbourhood .

Experimental view :

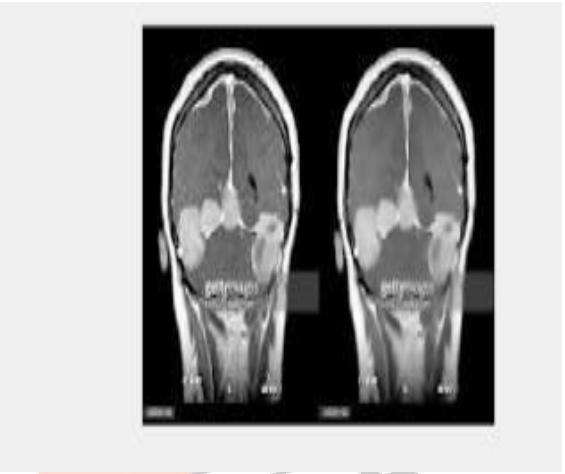


Fig 6.Edge preserving filter

(III) EROSION DILATION :

Dilation and Erosion are basic morphological processing operations that produce contrasting results when applied to either gray-scale or binary images. Erosion is used for removing irrelevant size details from a binary image. Erosion shrinks the image. It leads to thinning. It can strip away extrusions. Erosion is the counter-process of dilation. If dilation enlarges an image then erosion shrinks the image. The erosion operation usually uses a structuring element for probing and reducing the shapes contained in the input image.

Experimental view :

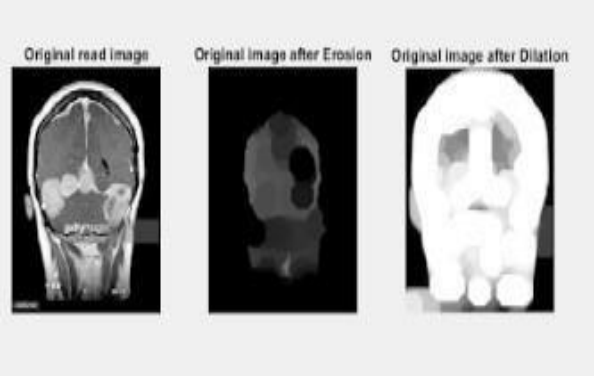


Fig7.Erosion Dilation

(IV) PLOT HISTOGRAM THREE CHANNEL :

Histogram is a conspire between number of pixel and pixel intensity. Bar graph can be used to plot the histogram. The histogram code operates by first reading the grayscale value at the first entry and upcoming with pixel intensity between 0 and 255. It increases the whole number of pixels and then it will travel to the next row or column entry awaiting it finishes analyzing all the raster data. However, while it is reading each entry, if it picks up pixel intensity value more than once it will augment that particular value.

Experimental view :

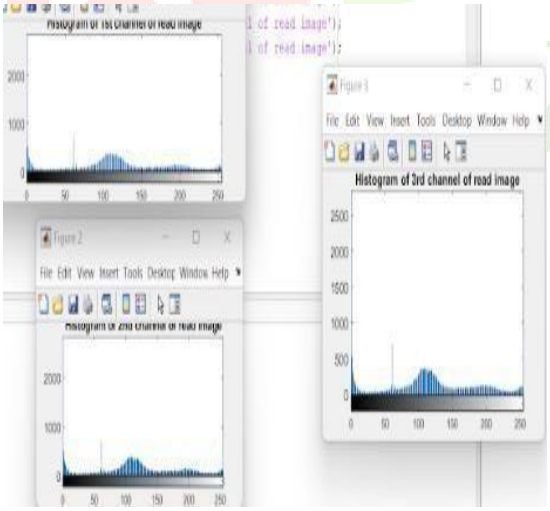


Fig 8.Plot histogram three channel

III. TUMOUR DETECTION

Brain Tumour is the unconstrained growth of bizarre cells in brain. In this work, dicom Magnetic Resonance Image (MRI) is taken as an input and tried to extract tumour cells fromthe input image.

Convolutional Neural Network:

Classifier models can be basically divided into two categories respectively which are generative models based on hand-crafted features and discriminative models based on traditional learning such as support vector machine (SVM), Random Forest (RF) and Convolutional Neural Network (CNN). One difficulty with methods based on hand- crafted features is that they often require the computation of a large number of features in order to be accurate when used with many traditional machine learning techniques. This can make them slow to compute and expensive memory-wise. More efficient techniques employ lower numbers of features, using dimensionality reduction like PCA (Principle Component Analysis) or feature selection methods, but the reduction in the number of features is often at the cost of reduced accuracy

.Brain tumor segmentation employ discriminative models because unlike generative modelling approaches, these approach exploit little prior knowledge on the brain instead mostly on the extraction of [a large number of] low level image features, directly modelling the relationship between these features and the label of a given voxel. In our project, we have used the Convolutional Neural Network .processes closely knitted data used for image classification, image processing, face detection etc. It is a specialized 3D structure with specialized NN analyzing RGBlayers of an image . Unlike others, it analyses one image at a time, identifies and extracts important features and uses them to classify the image.

Neural Networks (Conv Nets) automatically learns mid-level and high-level representations or abstractions from the input training data. The main building block used to construct a CNN architecture is the convolutional layer. It also consists of several

other layers, some of which are described as below:

- InputLayer-
  It takes in the raw pixel value of input image
- Convolutional Layer- It is the first layer toextract features from an input image Convolutionpreserves the relationship between pixels by learning image features using small squares ofinput data. It is a mathematical operation thattakes two inputs such as image matrix and a filteror kernel to generate a feature map Convolutionof an image with different filters can performoperations such as edge detection, blur and sharpen by applying filters.
- ActivationLayer- It produces a single output based on the weighted sum of inputs .Pooling Layer-Pooling layers section would reduce the number of parameters when the images are too large. Spatial pooling (also called sub sampling or down sampling) reduces the dimensionality of each map but retains important information. Fully Connected Layer-The layer we call as FC layer, we flattened our matrix into vector and feed it into a fully connected layer like a neural network. the feature map matrix will be converted as column vector (x1, x2, x3, …). With the fully connected layers, we combined these features together to create a model. For classifying input image into various classes based on training set. Drop out Layer-It prevents nodes in a network from co-adapting to each other.

Experimental view :

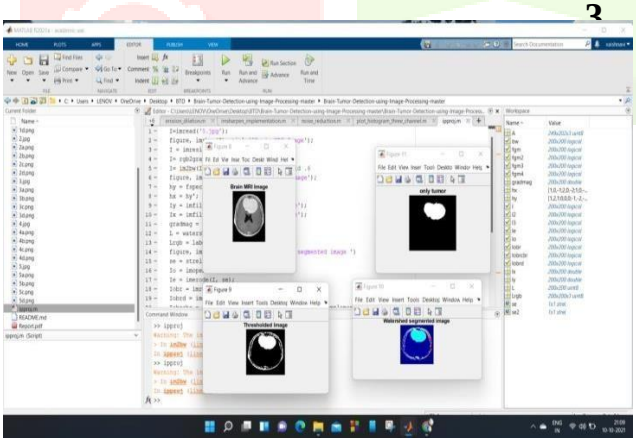


Fig 10.Tumour Detection

IV. CONCLUSION

Our projected it features a larger accuracy than different existent strategies for classifying tumor kind to be either as Malignant or Benign. Here we projected automatic brain tumor detection by using Convolutional Neutral Network (CNN) classification. This could effectively locate tumor lesions, and better results were obtained in correlation coefficient, sensitivity and specificity. Compared with 2D detection network, this detection accuracy is significantly improved.

V. REFERENCES

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3. Brain Tumor Detection Using Convolutional Neural Network Tonmoy Hossain1* , Fairuz Shadmani Shishir2@ , Mohsena Ashraf3# MD Abdullah Al Nasim4&, Faisal Muhammad Shah5
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