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Brain Tumor Classification using Convolution Neural Network and Size Estimation by Marker Based Watershed Segmentation

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Abstract: ***Brain tumor classification and segmentation in the medical field is still a challenging task. Because we cannot identify through our naked eyes. Even Though several algorithms and methods developed to segment the brain tumor still accuracy is needed .By the single level classification we may not obtain the accurate result. So we propose the CNN (Convolution Neural Network) classifier which contains several layers. The convolution neural network uses kernals.The classification here is used to find the brain tumors such as glioma,meningioma and pituitary .The classified image is segmented using the watershed algorithm which segments based on the intensity.The segmentation employs here is to find the size of the tumor.***

Keywords: ***Convolution neural network, Watershed segmentation, Glioma, meningioma, pituitary.***

I. INTRODUCTION

Brain tumor is the abnormal growth of cells within the brain. Brain tumors are often primary or secondary. A primary brain tumor originates within the brain itself or tissues adjacent to that, i.e. the brain-covering membranes (meninges)[6], bone nerves, endocrine or endocrine gland, whereas a secondary brain tumor happens once cancer cells from alternative organs like respiratory organ, kidney, breast, etc. unfold to the brain [3]. Primary brain tumor basically arises attributable to the mutations of their deoxyribonucleic acid. These mutations enable the abnormal cell to grow and therefore the traditional cell dies. It will cause brain harm and typically it is often serious

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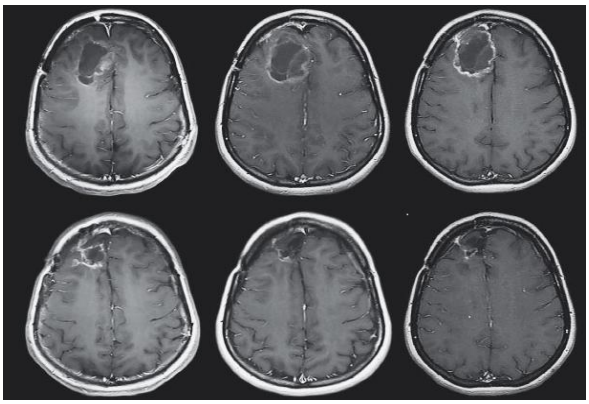


Figure 1: Brain Tumor Image

The computer-aided system [2] implication is useful for detection. In the stages of tumor growth, Associate in nursing economical and automatic system for classifying tumor supports physicians to interpret the medical pictures and aids in specialist's call. Through spending reduced time, the grading of tumor is performed during this study and it provides increased accuracy. Additionally, the whole classification procedure is noninvasive. For analyzing the medical pictures, enough focus had been given for the aim of designation. The interest in the domain of health-related techniques[3] and topics are emerging currently because the presence of contemporary milliliter techniques has evidenced its efficaciousness in resolution totally different issues. Several studies are conducted in several growth classification using MRI, chiefly organic process algorithms, mister brain pictures and artificial neural networks (ANN) , support vector machine (SVM) and hybrid intelligent techniques[5] at the shallow millilitre algorithms that are accustomed differentiate the abnormal and traditional categories of images in brain mister that are denoted through existing works. With a read to classify totally different brain tumors types and Glioma [1] grades, SVM is examined in [8].

II. RELATED WORK

There are several classification and segmentation algorithms developed to find the brain tumor. But there are few problems faced in each and every algorithms

Intensity based segmentation methods such as edge detection [2], thresholding [4] are very fast and easily adjustable. They majorly work on the high intensities, because intensity plays a vital role in differentiating tumor and non tumor images. But these methods are highly sensitive to noises.

Human brain is largely the same over the midsagittal plane. Tumors appear on one of the central hemispheres result asymmetric between the hemispheres [7]. So asymmetric analysis may not be applicable to find the tumor in the midsagittal plane

The contour/surface evolution method majorly used for 2D and 3D tumor image segmentation [9]. It works on splitting and merging of an image in natural way but it does not find out the initial tuning parameters

Graph based seeded segmentation[8] is the best interactive algorithm that provides optimizing results but it needs manual seed selection to distinguish the tissues in tumor images[10].

III. METHODOLOGY

The proposed methodology contains preprocessing, CNN classification and watershed segmentation.

Preprocessing:

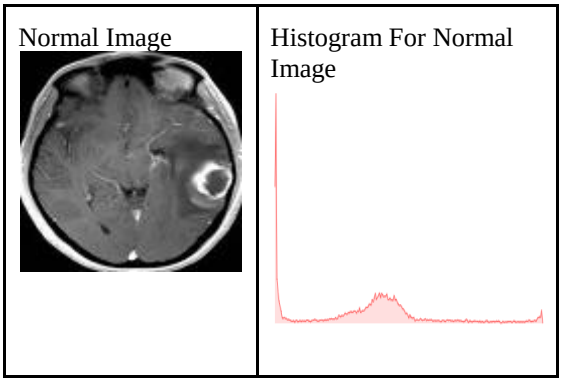
The histogram equalization is the preprocessing technique employed here. Histogram equalization is used to enhance and improve the contrast of the images. It helps to achieve high intensity values for the images.

Classification Using CNN:

CNN contains the weighted neurons and biases. It computes the dot product value between the input and weights which follows the nonlinearity. The convolution layer is having more than one convolution layer with the ReLU activation function and pooling step.

Convolution Layer:

The convolution layer extract the feature from the input brain image and the next convolution layers is linked only by the component. The dot product obtained from the respective field of an image and the kernel (3*3) which results in a single integer called feature map. Then again we have to slide the kernel with the respective same field with the stride value and obtain the dot product. The process is iterated throughout the whole image. The weights and biases obtained from the dot product is called the feature maps which is used for the input of next layers.



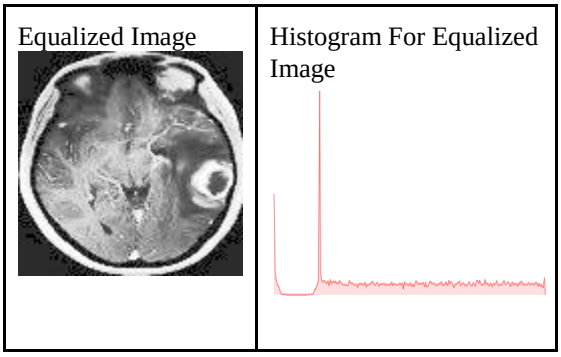


Figure 2: Histogram equalization

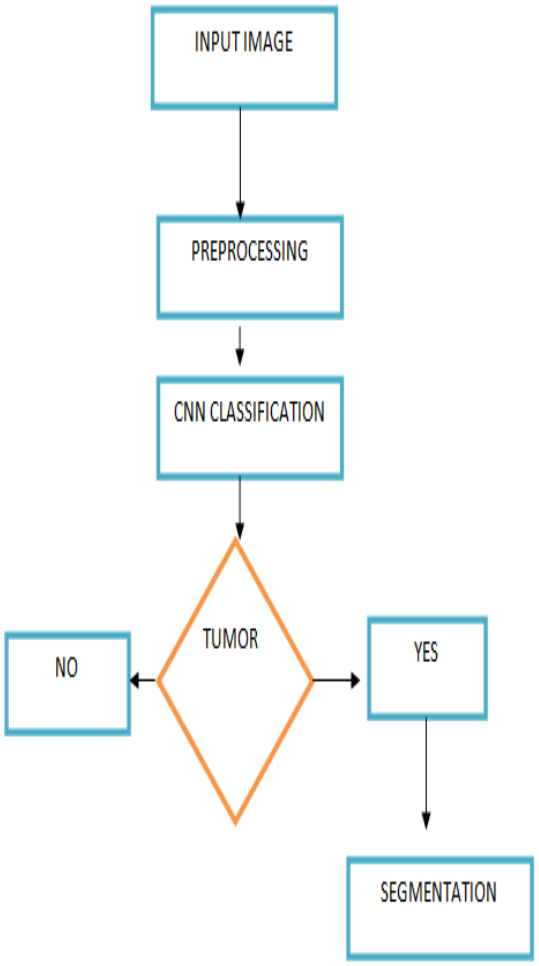


Figure 3: Flow Chart

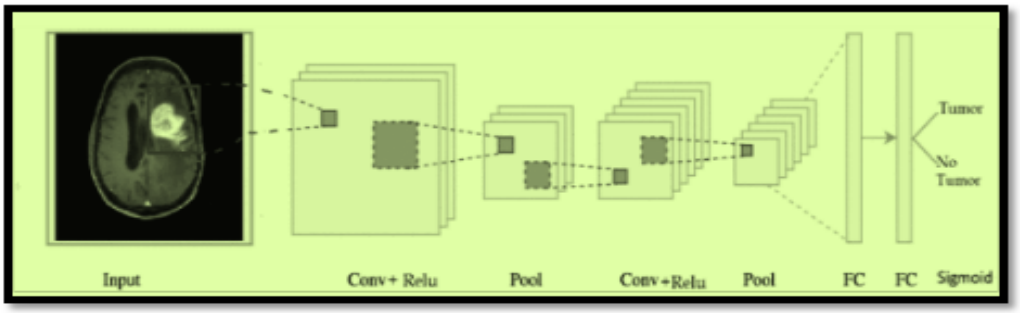


Figure 4: CNN Layers

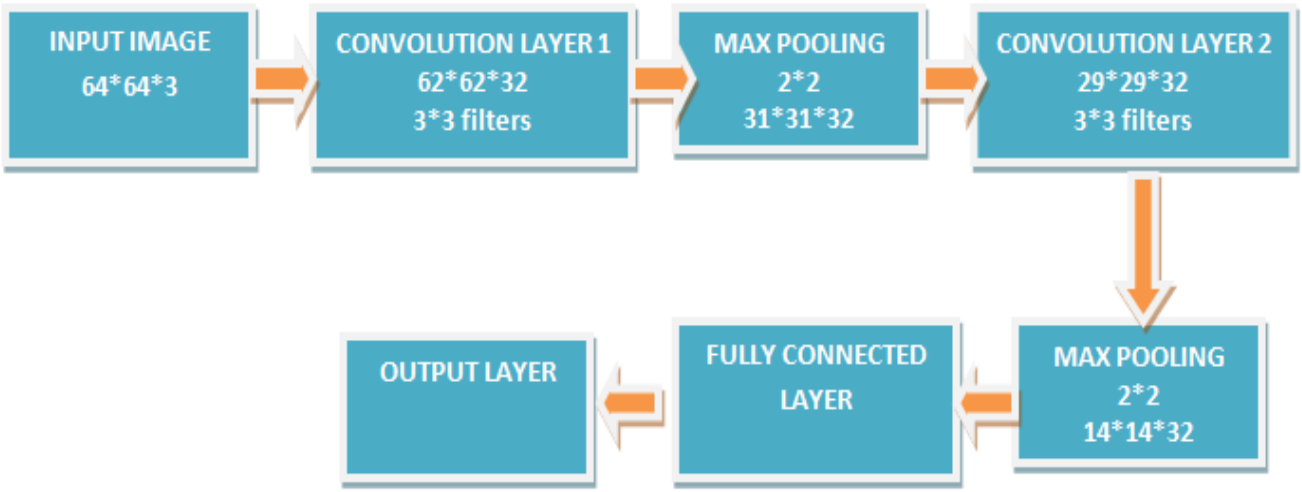


Figure 5: Block Diagram for Convolution Neural Network

Rectifier Linear Unit:

The rectilinear activation function is a linear function that results in the output directly as positive or zero .It has no vanishing gradient point. It is obtained from the function

$$F(x) = \max(x,0) \quad (1)$$

The data value in the feature map is positive then it will be given directly as input to the next layer but if it is negative it changes to zero.

Max Pooling Layer:

The pooling layer which reduces the dimension of the image to the control fit. It is the down sampling process usually followed after the ReLu layer. It operates on each feature maps to create the same number of feature maps.2*2 pixels is applied with the stride of value of 2.

Fully Connected Layer:

The fully connected layer flattens the image and turns into a single image .Then applies weight over the image and predicts the correct label to classify the image .Fully connected layer finally displays whether the brain image has a tumor or not. The classified image results the tumor as glioma, meningioma and pituitary.

Marker Based Watershed Segmentation:

Segmentation using the marker based watershed provides the better segmentation results because of the internal and external point markers. The internal markers which identifies the object of required regions which is the foreground, the value is set as 1 and external markers which identifies the background regions which set as 0.Finally the borders are set as -1.Finally the segmented image is resulted to find the size of the tumor

Size= (sqrt (w)*0.264) sq.mm (2)

where w is the number total number of white pixels after segmentation

IV. PERFORMANCE AND RESULTS

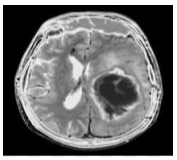
The performance of the system is measured using the metrics such as precision, recall and f1-Score.The precision, recall and f1-score was calculated using the formula

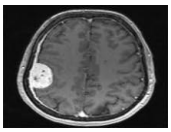
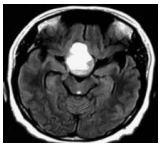
$$Precison = \frac{True\ Positive}{True\ Positive + False\ Positive} \quad (3)$$

$$Recall = \frac{True\ Positive}{True\ Positive + False\ Negative} \quad (4)$$

$$F1 - Score = \frac{2 \times Precision \times Recall}{Precision + Recall} \quad (5)$$

Table 1: Performance measurement

Class	Precision	Recall	F1-Score
 GLIOMA	0.87	0.86	0.88

 MENINGIOMA	0.94	0.96	0.95
 PITUITARY	0.98	0.99	0.97

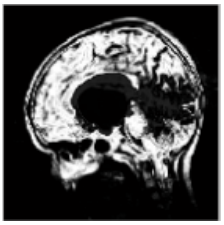


Figure 6: Input Image

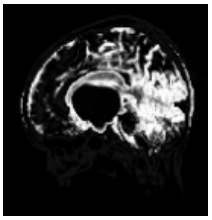


Figure 7: Histogram equalized image

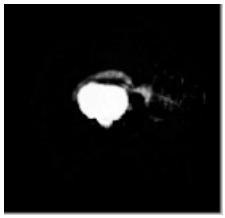


Figure 8: Segmented image

The classified image segments the tumor as Glioma or meningioma or pituitary and estimated the size of the tumor

V. CONCLUSION AND FUTURE ENHANCEMENT

The main goal is to segment the brain tumor image and to find the size of the tumor. The CNN classification and marker based watershed algorithm provides better results than other algorithms. There are 856 training and 320 testing datasets are used which provides better results in classification. The performance measures such as precision, recall and f1-score is the best parameters to evaluate the performances. The number of convolution layer used here is 2 and in future the number of convolution layer is increase to achieve the much better results

REFERENCES

1. D. A. Gutman, L. A. Cooper, S. N. Hwang, C. A. Holder, J. Gao, T. D. Aurora, W. D. Dunn, Jr., L. Scarpace, T. Mikkelsen, R. Jain, et al., "MR imaging predictors of molecular profile and survival: multi-institutional study of the TCGA glioblastoma data set," Radiology, vol. 267, no. 2, pp. 560-9, May 2013.
2. D. Bhattacharyya and T. H. Kim, "Brain tumor detection using MRI image analysis," Communications in Computer and Information Science, vol. 151, pp. 307-314, 2011.
3. C. L. Biji, D. Selvathi, and A. Panicker, "Tumor detection in brain magnetic resonance images using modified thresholding techniques," Communications in Computer and Information Sicence, vol. 4, pp. 300-308, 2011.
4. P. Gibbs, D. L. Buckley, S. J. Blackband, and A. Horsman, "Tumour volume determination from MR images by morphological segmentation," Physics in Medicine and Biology, vol. 41, no. 11, pp. 2437-46, Nov 1996.
5. R. Ratan, S. Sharma, and S. K. Sharma, "Brain tumor detection based on multi-parameter MRI image analysis," International Journal on Graphics, Vision and Image Processing, vol. 9, no. 3, pp. 9-11, 2009.
6. T. M. Hsieh, Y. M. Liu, C. C. Liao, F. Xiao, I. J. Chiang, and J. M. Wong, "Automatic segmentation of meningioma from non-contrasted brain MRI integrating fuzzy clustering and region growing," BMC Medical Informatics and Decision Making, vol. 11, p. 54, 2011.
7. B. N. Saha, N. Ray, R. Greiner, A. Murtha, and H. Zhang, "Quick detection of brain tumors and edemas: A bounding box method using symmetry," Computerized Medical Imaging and Graphics, vol. 36, no. 2, pp. 95-107, 2012.
8. J. Jiang, Y. Wu, M. Huang, W. Yang, W. F. Chen, and Q. J. Feng, "3D brain tumor segmentation in multimodal MR images based on learning population- and patient-specific feature sets," Computerized Medical Imaging and Graphics, vol. 37, no. 7-8, pp. 512-521, Jun 28 2013.
9. J. Sachdeva, V. Kumar, I. Gupta, N. Khandelwal, and C. K. Ahuja, "A novel content-based active contour model for brain tumor segmentation," Magnetic Resonance Imaging, vol. 30, no. 5, pp. 694-715, Jun 2012.
10. Y. Wu, W. Yang, J. Jiang, S. Q. Li, Q. J. Feng, and W. F. Chen, "Semi-automatic segmentation of brain tumors using population and individual information," Journal of Digital Imaging, vol. 26, no. 4, pp. 786-796, 2013.

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