Brain Tumor Detection using CNN

A Mini Project Report Submitted in Partial Fulfillment of

the Requirements for the Degree of

Bachelor of Technology

in

Information Technology

by

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Dec, 2021

DECLARATION

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief. It contains no matter previously published or written by any other person nor material which to substantial extent has been accepted to the award of any degree or diploma of the university or other institute of higher learning except where due acknowledge has been made in the text.

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CERTIFICATE

This is to certify that the project titled "**Brain Tumor Detection using CNN**" which is submitted by

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in partial fulfillment of the requirement for the award of the degree of Bachelor of Technology in Information Technology to PSIT College of Engineering, Kanpur, affiliated to Dr. A.P.J. Abdul Kalam Technical University, Lucknow during the academic year 2020-21, is the record of candidate's own work carried out by him/her under my supervision. The matter embodied in this report is original and has not been submitted for the award of any other degree.

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ABSTRACT

The human brain is the major controller of the humanoid system. The abnormal growth and division of cells in the brain lead to a brain tumor, and the further growth of brain tumors leads to brain cancer. In the area of human health, Computer Vision plays a significant role, which reduces the human judgment that gives accurate results. CT scans, X-Ray, and MRI scans are the common imaging methods among magnetic resonance imaging (MRI) that are the most reliable and secure. MRI detects every minute objects. Our paper aims to focus on the use of different techniques for the discovery of brain cancer using brain MRI. In this study, we performed pre-processing using the bilateral filter (BF) for removal of the noises that are present in an MR image. This was followed by the binary thresholding and Convolution Neural Network (CNN) segmentation techniques for reliable detection of the tumor region. Training, testing, and validation datasets are used. Based on our machine, we will predict whether the subject has a brain tumor or not. The resultant outcomes will be examined through various performance examined metrics that include accuracy, sensitivity, and specificity. It is desired that the proposed work would exhibit a more exceptional performance over its counterparts.

KEYWORDS: Brain tumor, Magnetic resonance imaging, Adaptive Bilateral Filter, Convolution Neural Network.

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Chapter 1

Introduction

Medical imaging is the technique and process of creating visual representations of the interior of a body for clinical analysis and medical intervention, as well as visual representation of the function of some organs or tissues. Medical imaging seeks to reveal internal structures hidden by the skin and bones, as well as to diagnose and treat disease. Medical imaging also establishes a database of normal anatomy and physiology to make it possible to identify abnormalities. The medical imaging processing refers to handling images by using the computer. This processing includes many types of techniques and operations such as image gaining, storage, presentation, and communication. This process pursues the disorder identification and management. This process creates a data bank of the regular structure and function of the organs to make it easy to recognize the anomalies. This process includes both organic and radiological imaging which used electromagnetic energies (X-rays and gamma), sonography, magnetic, scopes, and thermal and isotope imaging. There are many other technologies used to record information about the location and function of the body. Those techniques have many limitations compared to those modulates which produce images. An image processing technique is the usage of a computer to manipulate the digital image. This technique has many benefits such as elasticity, adaptability, data storing, and communication. With the growth of different image resizing techniques, the images can be kept efficiently. This technique has many sets of rules to perform in the images synchronously. The 2D and 3D images can be processed in multiple dimensions.

1.1 Brain anatomy:

The brain tumor is one all the foremost common and, therefore, the deadliest brain diseases that have affected and ruined several lives in the world. Cancer is a disease in the brain in which cancer cells ascends in brain tissues. Conferring to a new study on cancer, more than one lakh people are diagnosed with brain tumors every year around the globe. Regardless of stable efforts to overcome the complications of brain tumors, figures show unpleasing results for tumor patients. To contest this, scholars are working on computer vision for a better understanding of the early stages of tumors and how to overcome using advanced treatment options. Magnetic resonance (MR) imaging and computed tomography (CT) scans of the brain are the two most general tests to check the existence of a tumor and recognize its position

for progressive treatment decisions. These two scans are still used extensively for their handiness, and the capability to yield high-definition images of pathological tissues is more. At present, there are several other conducts offered for tumors, which include surgery, therapies such as radiation therapy, and chemotherapy. The decision for which treatment relies on the many factors such as size, kind, and grade of the tumor present in the MR image. It's conjointly chargeable for whether or not cancer has reached the other portions of the body. Precise sighting of the kind of brain abnormality is enormously needed for treatment operations with a resolution to diminish diagnostic errors. The precision is often makeshift utilizing computer-aided diagnosis (CAD) systems. The essential plan of computer vision is to produce a reliable output, which is an associate estimation to assist medical doctors in image understanding and to lessen image reading time. These advancements increase the steadiness and correctness of medical diagnosis — however, segmenting an MR image of the tumor and its area itself a very problematic job. The occurrence of tumors in specific positions within the brain image without distinguishing picture intensities is an additional issue that makes a computerized detection of brain tumor and segmentation a problematic job.

1.2 Motivation For The Work:

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 MRI images because it is easy to examine and gives out accurate calcification and foreign mass location. The MRI is the most regularly utilized strategy for imaging brain tumors and the identification of its vicinity. The conventional technique for CT and MR image classification and detection of tumor cells remains largely supported for the human reviewing apart from different other methods. MR images are mainly used because there are non-destructive and non-ionizing. MR imaging offers high-definition pictures that are extensively utilized in discovering brain tumors. MRI has diverse schemes such as flair, T1-weighted, T2-weighted images. There are many image processing techniques such as pre-processing, segmentation of images, image improvements, feature extraction, and classifiers.

1.3 Problem Statement:

Our study deals with automated brain tumor detection and classification. Normally the anatomy of the brain is analyzed by MRI scans or CT scans. The aim of the paper is tumor identification in brain MR 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 MR brain images. The methods utilized are filtering, erosion, dilation, threshold, and outlining of the tumor such as edge detection. The focus of this project is MR brain images tumor extraction and its representation in simpler form such that it is understandable by everyone. The objective of this work is to bring some useful information in simpler form in front of the users, especially for the medical staff treating the patient. The aim of this work is to define an algorithm that will result in extracted image of the tumor from the MR brain image. The resultant image will be able to provide information like size, dimension and position of the tumor, and its boundary provides us with information related to the tumor that can prove useful for various cases, which will provide a better base for the staff to decide the curing procedure. Finally, we detect whether the given MR brain image has tumor or not using Convolution Neural Network.

1.4 Scope:

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

Chapter 2

Literature Survey

In Medical diagnosis, robustness and accuracy of the prediction algorithms are very important, because the result is crucial for treatment of patients. There are many popular classification and clustering algorithms used for prediction. The goal of clustering a medical image is to simplify the representation of an image into a meaningful image and make it easier to analyze. Several Clustering and Classification algorithms are aimed at enhancing the prediction accuracy of diagnosis process in detecting abnormalities.

In the literature survey we provide a brief summary of the different methods thathave been proposed for clustering over the period of 2002 to 2018.We have been though25 papers each of which has a unique approach towards segmentation in some parameteror the other. The summaries of each of the papers are provided below.

- **A. Sivaramakrishnan And Dr. M. Karnan "A Novel Based Approach for Extraction Of Brain Tumor In MRI Images Using Soft Computing Techniques," International Journal Of Advanced Research In Computer And Communication Engineering, Vol. 2, Issue 4, April 2013.**

A. Sivaramakrishnan et al. (2013) [1] projected an efficient and innovative discovery of the brain tumor vicinity from an image that turned into finished using the Fuzzy C- approach grouping algorithm and histogram equalization. The disintegration of images is achieved by the usage of principal factor evaluation is done to reduce the extent of the wavelet coefficient. The outcomes of the anticipated FCM clustering algorithm accurately withdrawn tumor area from the MR images.

- **Asra Aslam, Ekram Khan, M.M. Sufyan Beg, Improved Edge Detection Algorithm for Brain Tumor Segmentation, Procedia Computer Science, Volume 58,2015, Pp 430-437, ISSN 1877-0509.**

M. M. Sufyan et al. [2] has presented a detection using enhanced edge technique for brain-tumor segmentation that mainly relied on Sobel feature detection. Their presentedwork associates the binary thresholding operation with the Sobel approach and excavates diverse extents using a secure contour process. After the completion of that process, cancer cells are extracted from the obtained picture using intensity values.

- **B.Sathya and R.Manavalan, Image Segmentation by Clustering Methods: Performance Analysis, International Journal of Computer Applications (0975 – 8887) Volume 29– No.11, September 2011.**

Sathya et al. (2011) [3], provided a different clustering algorithm such as K-means, Improvised K-means, C-means, and improvised C-means algorithms. Their paper presented an experimental analysis for massive dat=asets consisting of unique photographs. They analyzed the discovered consequences using numerous parametric tests.

- **Devkota, B. & Alsadoon, Abeer & Prasad, P.W.C. & Singh, A.K. & Elchouemi, A. (2018). Image Segmentation for Early Stage Brain Tumor Detection using Mathematical Morphological Reconstruction. Procedia Computer Science. 125. 115-123. 10.1016/j.procs.2017.12.017.**

B. Devkota et al. [4] have proposed that a computer-aided detection (CAD) approach isused to spot abnormal tissues via Morphological operations. Amongst all different segmentation approaches existing, the morphological opening and closing operations are preferred since it takes less processing time with the utmost efficiency in withdrawing tumor areas with the least faults.

- **K. Sudharani, T. C. Sarma and K. Satya Rasad, "Intelligent Brain Tumor lesion classification and identification from MRI images using a K-NN technique," 2015 International Conference on Control, Instrumentation, Communication and Computational Technologies (ICCICCT), Kumaracoil, 2015, pp. 777-780. DOI: 10.1109/ICCICCT.2015.7475384**

K. Sudharani et al. [5] presented a K- nearest neighbor algorithm to the MR images to identify and confine the hysterically full-fledged part within the abnormal tissues. The proposed work is a sluggish methodology but produces exquisite effects. The accuracyrelies upon the sample training phase.

- **Kaur, Jaskirat & Agrawal, Sunil & Renu, Vig. (2012). A Comparative Analysis of Thresholding and Edge Detection Segmentation Techniques. International Journal of Computer Applications.vol. 39.pp. 29-34. 10.5120/4898-7432.**

Jaskirat Kaur et al. (2012) [6] defined a few clustering procedures for the segmentationprocess and executed an assessment on distinctive styles for those techniques. Kaur represented a scheme to measure selected clustering techniques based on their steadiness in exceptional tenders. They also defined the diverse performance metric tests, such as sensitivity, specificity, and accuracy.

- **Li, Shutao, JT-Y. Kwok, IW-H. Tsang and Yaonan Wang. "Fusing imageswith different focuses using support vector machines." IEEE Transactionson neural networks 15, no. 6 (2004): 1555-1561.**

J.T. Kwok et al. [7] delivered wavelet-based photograph fusion to easily cognizance at the object with all focal lengths as several vision-related processing tasks can be carried out more effortlessly when wholly substances within the images are bright. In their work Kwok et al. investigated with different datasets, and results show that presented work is extra correct as it does not get suffering from evenness at different activity stages computations.

- **M. Kumar and K. K. Mehta, "A Texture based Tumor detection and automatic Segmentation using Seeded Region Growing Method," International Journal of Computer Technology and Applications, ISSN: 2229-6093, Vol. 2, Issue 4, PP. 855-859 August 2011.**

Kumar and Mehta [8] proposed the texture-based technique in this paper. They highlighted the effects of segmentation if the tumor tissue edges aren't shrill. The performance of the proposed technology may get

unwilling results due to those edges. The texture evaluation and seeded region approach turned into executed inside the MATLAB environment.

- **Mahmoud, Dalia & Mohamed, Eltaher. (2012). Brain Tumor Detection Using Artificial Neural Networks. Journal of Science and Technology. 13.31-39.**

Dalia Mahmoud et al. [9] presented a model using Artificial Neural Networks for tumor detection in brain images. They implemented a computerized recognition system for MR imaging the use of Artificial Neural Networks. That was observed that after the Elman community was used during the recognition system, the period time and the accuracy level were high, in comparison with other ANNs systems. This neural community has a sigmoid characteristic which elevated the extent of accuracy of the tumor segmentation.

- **Marroquin J.L., Vemuri B.C., Botello S., Calderon F. (2002) An Accurate and Efficient Bayesian Method for Automatic Segmentation of Brain MRI.In: Heyden A., Sparr G., Nielsen M., Johansen P. (eds) Computer Vision**
  — ECCV 2002. ECCV 2002. Lecture Notes in Computer Science, vol 2353.Springer, Berlin, Heidelberg.

L. Marroquin et al. [10] presented the automated 3d segmentation for brain MRI scans. Using a separate parametric model in preference to a single multiplicative magnificencewill lessen the impact on the intensities of a grandeur. Brain atlas is hired to find non- rigid conversion to map the usual brain. This transformation is further used to segmentthe brain from nonbrain tissues, computing prior probabilities and finding automatic initialization and finally applying the MPM-MAP algorithm to find out optimal segmentation. Major findings from the study show that the MPM-MAP algorithm is comparatively robust than EM in terms of errors while estimating the posterior marginal. For optimal segmentation, the MPM-MAP algorithm involves only the solution of linear systems and is therefore computationally efficient.

- **Minz, Astina, and Chandrakant Mahobiya. "MR Image Classification Using Adaboost for Brain Tumor Type." 2017 IEEE 7th International Advance Computing Conference (IACC) (2017): 701-705.**

Astina minz et al. [11] implemented an operative automatic classification approach forbrain image that projected the usage of the AdaBoost gadget mastering algorithm. Theproposed system includes three main segments. Pre-processing has eradicated noises inthe datasets and converted images into grayscale. Median filtering and thresholding segmentation are implemented in the pre-processed image.

- **Monica Subashini.M, Sarat Kumar Sahoo, "Brain MR Image Segmentation for TumorDetection using Artificial Neural Networks," International Journal of Engineering and Technology (IJET), Vol.5, No 2,Apr-May 2013.**

onica Subashini and Sarat Kumar Sahoo [12] has suggested a technique for detectingthe tumor commencing the brain MR images. They also worked on different techniques,which include pulse-coupled Neural Network and noise removal strategies for reinforcing the mind MRI images and backpropagation network for classifying the brainMRI images from tumor cells. They observed image enhancement and segmentation ofthe usage of their proposed technique, and the backpropagation network helps in the identification of a tumor in a brain MR image.

- **S. Li, J.T. Kwok, I.W Tsang, and Y. Wang, —Fusing Images with DifferentFocuses using Support Vector Machines, Proceedings of the IEEE transaction on Neural Networks, China, November 2007.**

Li et al. [13] report that edge detection, image segmentation, and matching are not easyto achieve in optical lenses that have long focal lengths. Previously, researchers have proposed many techniques for this mechanism, one of which is wavelet-based image fusion. The wavelet function can be improved by applying a discrete wavelet frame transform (DWFT) and a support vector machine (SVM). In this paper, the authors experimented with five sets of 256-level images. Experimental results

show that this technique is efficient and more accurate as it does not get affected by consistency verification and activity level measurements. However, the paper is limited to only one task related to fusion, and dynamic ranges are not considered during the calculation.

- **H. Yu and J.L. Fan, —Three-level Image Segmentation Based on Maximum Fuzzy Partition Entropy of 2-D Histogram and Quantum Genetic Algorithm, Advanced Intelligent Computing Theories, and Applications. With Aspects of Artificial Intelligence. Lecture Notes in Computer Science, Berlin, Heidelberg 2008.**

Yu et al. [14] state that image segmentation is used for extracting meaningful objects from an image. They propose segmenting an image into three parts, including dark, greyand white. Z-function and s-function are used for the fuzzy division of the 2D histogram. Afterward, QGA is used for finding a combination of 12 membership parameters, which have a maximum value. This technique is used to enhance image segmentation and the significance of their work is that three-level image segmentation is used by following the maximum fuzzy partition of 2D Histograms. QGA is selected for the optimal combination of parameters with the fuzzy partition entropy. The proposed method of fuzzy partition entropy of 2D histogram generates better performance than one-dimensional 3-level thresh holding method. Somehow, a large number of possible combinations of 12 parameters in a multi-dimensional fuzzy partition are used, and it is practically not feasible to compute each possible value; therefore, QGA can be used to find the optimal combination.

- **P.S. Mukambika, K Uma Rani, "Segmentation and Classification of MRI Brain Tumor," International Research Journal of Engineering and Technology (IRJET), Vol.4, Issue 7, 2017, pp. 683 – 688, ISSN: 2395-0056**

Mukambika et al. [15] proposed methodology for the subsequent stage's classification of the tumor, whether it is present or not. Their proposed work represents the comparative study of strategies used for tumor identification from MR images, namelythe Level set approach and discrete

wavelength transforms (DWT) and K-method segmentation algorithms. After that phase, feature extraction is done followed SVM classification.

- **Pan, Yuehao & Huang, Weimin & Lin, Zhiping & Zhu, Wanzheng & Zhou, Jiayin & Wong, Jocelyn & Ding, Zhongxiang. (2015). Brain tumor grading based on Neural Networks and Convolutional Neural Networks. Conference proceedings: Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE Engineering in Medicine and Biology Society. Conference. 2015. 699-702. 10.1109/EMBC.2015.7318458.**

Yuehao Pan et al., [16] has used brain MRI pix for getting useful statistics for classifyingbrain tumor. In their proposed method, they used Convolutional Neural Networks (CNN) algorithms for developing a brain tumor detection system. The performance of their CNN report is measured primarily based on sensitivity and specificity parameters, which have stepped forward when in comparison to the Artificial Neural Networks (ANN).

- **S. Pereira, A. Pinto, V. Alves, and C. A. Silva, "Brain Tumor Segmentation Using Convolutional Neural Networks in MRI Images," in IEEE Transactions on Medical Imaging, vol. 35, no. 5, pp. 1240-1251, May 2016.**

S. Pereira et al. [17] presented that magnetic resonance prevents physical segmentationtime in the medical areas. So, an automatic and reliable segmentation technique for identifying abnormal tissues by using Convolutional Neural Network (CNN) had been proposed in the research work. The massive three-dimensional and underlying roughness amongst brain images makes the process of segmenting the image a severe issue, so a robust methodology such as CNN is used.

- **S. Roy And S. K. Bandyopadhyay, “Detection and Qualification Of Brain Tumor From MRI Of Brain And Symmetric Analysis,” International Journal Of Information And Communication Technology Research, Volume 2 No.6, June 2012, Pp584-588**

Roy et al. (2012) [18] calculated the tumor affected area for proportioned

analysis. Theyconfirmed its software with numerous statistics groups with distinctive tumor sizes, intensities, and location. They showed that their algorithm could robotically hit upon and phase the brain tumor from the given photo. Image pre-processing consists of fleeting that pictures to the filtering technique to remove distractors found in given pictures. They first detect the tumor, segment it and then find out the area of tumor. Oneof the important aspects is that after performing the quantitative analysis, we can identify the status of an increase in the disease. They have suggested multi-step and modular approach to solve the complex MRI segmentation problem. Tumor detection is the first step in tumor segmentation. They have obtained good results in complex situations. The authors claim that MRI segmentation is one of the essential tasks in the medical area but boring and time-consuming if it is performed manually, so visually study of MRI is more interesting and faster.

- **Sankari Ali, and S. Vigneshwari. "Automatic tumor segmentation using convolutional neural networks." 2017 Third International Conference on Science Technology Engineering & Management (ICONSTEM) (2017): 268-272.**

A. Sankari and S. Vigneshwari [19] has proposed a Convolutional Neural Network (CNN) segmentation, which principally based on the brain tumor classification method.The proposed work used the non-linearity activation feature that's a leaky rectified linearunit (LReLU). They primarily focused on necessary capabilities, which include mean and entropy of the image and analyzed that the CNN algorithm is working higher for representing the complicated and minute capabilities of brain tumor tissues present in the MR Images.

- **T.U Paul and S.K. Bandyopadhyay, —Segmentation of Brain Tumor from Brain MRI Images Reintroducing K – Means with advanced Dual Localization +MethodTuhin, || International Journal of Engineering Research and Applications, Volume 3, Issue 1, June 2012, ISSN 2278-0882.**

T.U Paul and S.K. Bandyopadhyay [20] has presented the brain

segmentation that has automated the use of the Dual Localization technique. In the initial phase, the skull masks are generated for the brain MR images. The tumor areas are improvised using the K-manner procedure. In the final step of their proposed work, they evaluated by its dimensions such as length and breadth.

- **Vaishali et al. (2015) Wavelet-based feature extraction for brain tumor diagnosis—a survey. Int J Res Appl Sci Eng Technol (IJRASET) 3(V), ISSN: 2321-9653**

Vaishali [21] proposed a method that includes step by step procedure starting with image pre-processing followed by extraction of useful objects and finally classificationof tumor region. Pre-processing is completed to enhance the image using eliminating the noise via making use of Gaussian filters from the authentic ones. The next step is feature extraction, in which a magnified image is used to extract the feature using a symlet wavelet technique. The very last step is the classification of tumors by the use of a Support vector machine (SVM).

- **Varuna Shree, N., Kumar, T.N.R. Identification and classification of brain tumor MRI images with feature extraction using DWT and probabilistic neural network. Brain Inf. 5, 23–30 (2018) DOI:10.1007/s40708-017-0075-5**

Kumar and Varuna Shree [22] proposed work for the detection tumor region using discrete wavelength transforms (DWT). This work consists of three phases, namely animage enhancement using filtering technique, gray-level co-incidence matrix (GLCM)feature extraction of tumor in addition to DWT based tumor location developing

segmentation. It is used to improve overall performance and reduce complexity. The denoised accompanied by the aid of morphological filtering operations which put off the noises that can be even shaped subsequent segmentation technique. The PNN classifier is to use for classifying the abnormality, which is trained by different datasets,and the accuracy is measured within the detection of tumor region of mind MR images.

- **Vinotha, K., 2014. "Brain Tumor Detection and Classification Using Histogram Equalization and Fuzzy Support Vector Machine Approach," International Journal of Engineering and Computer Science ISSN2319- 7242 3(5): 5823-5827.**

K. Vinotha et al. [23] proposed brain tumor detection and the usage of the Histogram Equalization (HE) and the Fuzzy Support Vector Machine (FSVM) classification techniques. The brain MR image is pre-processed with histogram equalization and segmented the apprehensive components from the photo primarily based on the MRF algorithm for segmentation technique. MRF approach expanded the tumor segmentation accuracy through which the overall performance of the proposed approachchanged into advanced.

- **Sing, J.K. & Basu, D.K. & Nasipuri, Mita & Kundu, Megha. (2003). Improved k-means algorithm in the design of RBF neural networks. 2. 841**

  - 845 Vol.2. 10.1109/TENCON.2003.1273297.

Sing et al. [24] propose a fuzzy adaptive RBI based neural network for MR brain image segmentation. The hidden layer neuron of FARBF-NN neurons has been fuzzified to reduce noise effect. Basu et al. assert that the medical image segmentation approach involves a combination of texture and boundary information. The authors maintain thatgeometric algebra can be used to obtain volumetric data representation using spheres, nonrigid registration of spheres and real-time object tracking. Major contribution of the proposed approach is that the use of the

marching cube algorithm reduces the number of primitives to model volumetric data and uses a lesser number of primitives for the registration process, and thus makes the registration process faster. However, the studyhas employed images obtained from CT scans, which has its own limitations like blurred boundaries and similar grey levels between healthy and non-healthy tissues.

- **Shi, Z., He, L., Suzuki, K., Nakamura, T., & Itoh, H. (2009). Survey on Neural Networks Used for Medical Image Processing. International Journal of computational science, 3(1), 86–100.**

Shi et al. [25] employed neural networks for medical image processing, including the key features of medical image pre-processing, segmentation, and object detection and recognition. The study employed Hopfield and feedforward neural networks. The feed-forward and Hopfield neural networks are simple to use and easy to implement. The added advantage of Hopfield neural networks is that it does not require pre-experimentalknowledge. The time required to resolve image processing predicament is substantially reduced by using a trained neural network

- **Detection of Tumor in MRI Images Using Artificial Neural Networks**

Automatic defects detection in MR images is very important in many diagnostic and therapeutic applications. This work has introduced one automatic brain tumor detectionmethod to increase the accuracy and yield and decrease the diagnosis time. The goal isclassifying the tissues into two classes of normal and abnormal. MR images that have been used here are MR images from normal and abnormal brain tissues. This method uses from neural network to do this classification. The purpose of this project is to classify the brain tissues to normal and abnormal classes automatically, which saves the radiologist time, increases accuracy and yield of diagnosis.

- **Survey on Brain Tumor Detection Techniques Using Magnetic ResonanceImages**

The brain tumor is an abnormal growth of cells inside the skull which causes damage to the other cells necessary for functioning human brain. Brain tumor detection is a challenging task due to the complex structure of the human brain. MRI images generated from MRI scanners using strong magnetic fields and radio waves to form images of the body which helps for medical diagnosis. This paper gives an overview ofthe various techniques used to detect the tumor in the human brain using MRI images. A Neural Network-based Method for Brain Abnormality Detection in MRImages Using Gabor Wavelets

Nowadays, automatic defects detection in MR images is very important in many diagnostic and therapeutic applications. This paper introduces a Novel automatic brain tumor detection method that uses T1, T2_weighted and PD, MR images to determine any abnormality in brain tissues. Here, it has been tried to give a clear description from brain tissues using Gabor wavelets, energy, entropy, contrast and some other statistic features such as mean, median, variance, correlation, values of maximum and minimum intensity. It is used from a feature selection method to reduce the feature space too. thismethod uses from neural network to do this classification. The purpose of this project is to classify the brain tissues to normal and abnormal classes automatically, which saves the radiologist time, increases accuracy and yield of diagnosis.

Chapter 3

Challenges In Tumor Classification

The identification of tumor is a very challenging task. The location, shape and the structure of tumor varies significantly from patient to patient which makes the segmentation a very challenging task. In the figure shown below, we have shown some images of the same brain slice from different patients, which clearly reflect the variation of the tumor. We can clearly see that the location of the tumor is different in all the 8 images/patients shown below. To make it worse, the shape and the intra-tumoral structure is also different for all the eight patients/images. In fact, there can be more than one region of the tumor as can be seen from the images below. This indeed reflects the complexity of automatic segmentation.

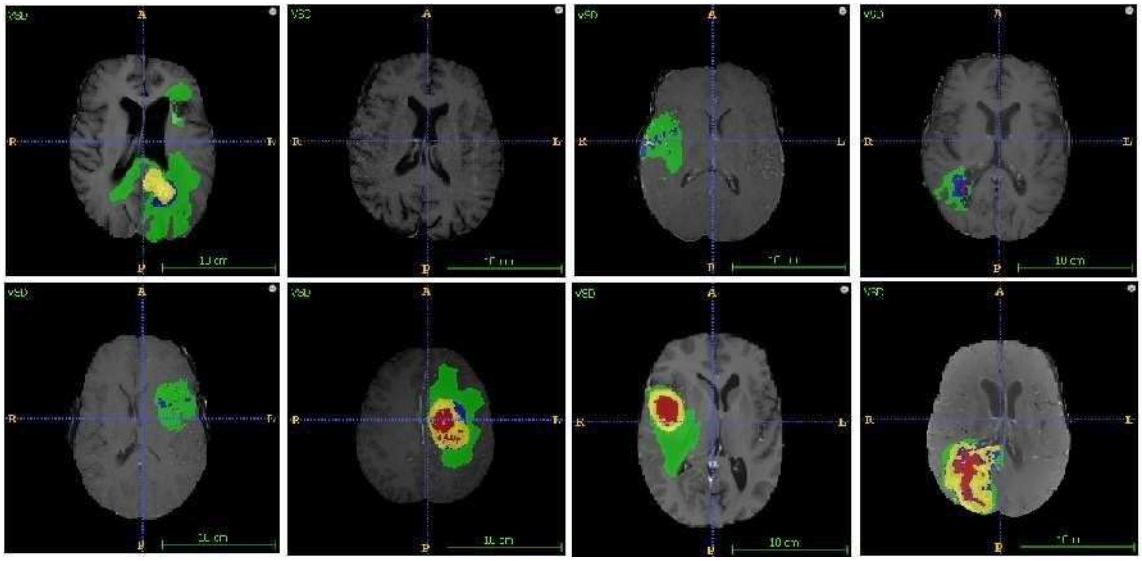


Fig.3.1 Location of tumors in eight different images.

Chapter 4
Module Division

This provides the architecture of the system that would be developed by our hands. It consists of six steps where the execution starts from taking an input image from the data set followed by the image pre-processing, image enhancement, Image segmentation using binary thresholding and the brain tumor classification using Convolutional Neural Network. Finally, the output is observed after all the above- mentioned steps are completed.

Each module is unique in its own way. Every step has its importance. This architecture also includes a testing and training data set. The data set used is has been downloaded from Kaggle which consists of nearly 2000 images that are used to test andtrain the system. The input image is pre-processed by using the noise filter like MedianFilter and Bilateral Filter and the image is enhanced using the Sobel Filter. Then the obtained image using segmented using binary thresholding and morphological operations are performed on it. Finally, the image classification is done using Convolutional Neural Network to predict whether the tumor is present or not.

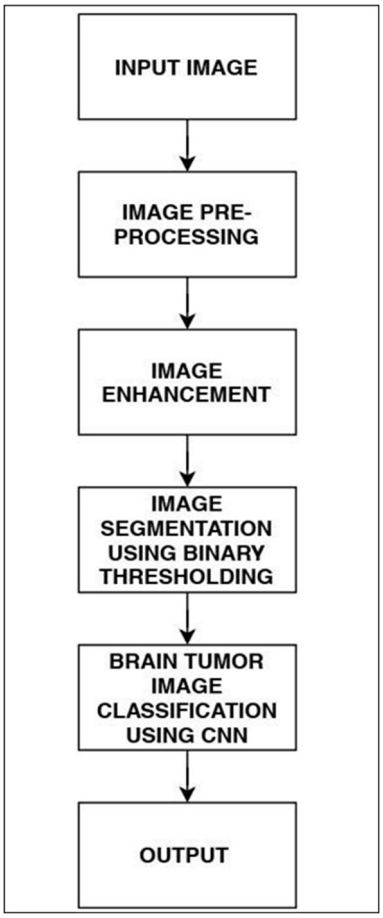


Fig.4.1 Module Division

Module 1: Image Preprocessing And Image Enhancement

3.1.1 Image Preprocessing :

The Brain MRI image dataset has been downloaded from the Kaggle. The MRIdataset consists of around 1900 MRI images, including normal, benign, and malignant.These MRI images are taken as input to the primary step. The pre-processing is an essential and initial step in improving the quality of the brain MRI Image. The critical steps in pre-processing are the reduction of impulsive noises and image resizing. In theinitial phase, we convert the brain MRI image into its corresponding gray-scale image. The removal of unwanted noise is done using the adaptive bilateral filtering technique to remove the distorted noises that are present in the brain picture. This improves the diagnosis and also increase the classification accuracy rate.

3.1.2 Image Enhancement :

Image enhancement is a technique used to improve the image quality and perceptibility by using computer-aided software. This technique includes both objectiveand subjective enhancements. This technique includes points and local operations. Thelocal operations depend on the district input pixel values. Image enhancement has two types: spatial and transform domain techniques. The spatial techniques work directly onthe pixel level, while the transform technique works on Fourier and later on the spatialtechnique.

Edge detection is a segmentation technique that uses border recognition of strictly linked objects or regions. This technique identifies the discontinuity of the objects. Thistechnique is used mainly in image study and to recognize the parts of the image where a huge variation in intensity arises.

Module 2: Image Segmentation Using Binary Threshold

Image segmentation is a technique of segregating the image into many parts. The basic aim of this segregation is to make the images easy to analyze and interpret with preserving the quality. This technique is also used to trace the objects' borders within the images. This technique labels the pixels according to their intensity and characteristics. Those parts represent the entire original image and acquire its characteristics such as intensity and similarity. The image segmentation technique is used to create contours of the body for clinical purposes. Segmentation is used in machine perception, malignant disease analysis, tissue volumes, anatomical and functional analyses, virtual reality visualization, and anomaly analysis, and object definition and detection.

Segmentation methods has ability to detect or identify the abnormal portion from the image which is useful for analyzing the size, volume, location, texture and shape of the extracted image. MR image segmentation with the aid of preserving the threshold information, which is convenient to identify the broken regions extra precisely. It was a trendy surmise that the objects that are placed in close propinquity might be sharing similar houses and characteristics.

Module 3: Brain Tumor Image Classification Using Convolutional Neural Network

Classification is the best approaches for identification of images like any kind of medical imaging. All classification algorithms are based on the prediction of image, where one or more features and that each of these features belongs to one of several classes.

An automatic and reliable classification method Convolutional Neural Network (CNN) will be used since it is robust in structure which helps in identifying every minute details. A Convolutional Neural Network (ConvNet/CNN) is a Deep Learning algorithm which can take in an input image, assign importance to various aspects/objects in the image and be able to differentiate one from the other. The pre- processing required in a ConvNet is much lower as compared to other classification algorithms. While in primitive methods filters are hand-engineered, with enough training, ConvNet have the ability to learn these filters/characteristics.

A ConvNet is able to successfully capture the spatial and temporal dependencies in an image through the application of relevant filters. The architecture performs a better fitting to the image dataset due to the reduction in the number of parameters involved and reusability of weights. In other words, the network can be trained to understand thesophistication of the image better. The role of the ConvNet is to reduce the images intoa form which is easier to process, without losing features which are critical for getting a good prediction.

For this step we need to import Keras and other packages that we're going to use inbuilding the CNN. Import the following packages:

- *Sequential* is used to initialize the neural network.
- *Convolution2D* is used to make the convolutional network that deals with theimages.
- *MaxPooling2D* layer is used to add the pooling layers.
- *Flatten* is the function that converts the pooled feature map to a single column thatis passed to the fully connected layer.
- *Dense* adds the fully connected layer to the neural network.

Chapter 5
Experimental Analysis And Results

5.1 System Configuration

5.1.1 Software Requirements

- Windows: Python 3.6.2 or above, PIP and NumPy 1.13.1

Python

Python is an interpreted, high-level, general purpose programming language created by Guido Van Rossum and first released in 1991, Python's design philosophyemphasizes code Readability with its notable use of significant Whitespace. Its language constructs and object-oriented approach aim to help programmers write clear, logical code for small and large-scale projects. Python is dynamically typed and garbage collected. It supports multiple programming paradigms, including procedural, object-oriented, and functional programming.

Pip

It is the package management system used to install and manage software packages written in Python.

Numpy

NumPy is a general-purpose array-processing package. It provides a high-performance multidimensional array object, and tools for working with these arrays. It is the fundamental package for scientific computing with Python. It contains variousfeatures including these important ones:

- A powerful N-dimensional array object
- Sophisticated (broadcasting) functions
- Tools for integrating C/C++ and Fortran code
- Useful linear algebra, Fourier transform, and random number capabilities

Pandas

Pandas is the most popular python library that is used for data analysis. It provides highly optimized performance with back-end source code is purely writtenin *C* or *Python*. We can analyze data in pandas with

1. Series
2. Data frames

Anaconda

Anaconda is a free and open-source distribution of the Python and R programming languages for scientific computing that aims to simplify package management and deployment. Package versions are managed by the package management system conda. The Anaconda distribution includes data-science packages suitable for Windows, Linux, and macOS. Anaconda distribution comes with 1,500 packages selected from PyPI as well as the conda package and virtual environment manager. It also includes a GUI, Anaconda Navigator, as a graphical alternative to the command-line interface (CLI).

Jupyter Notebook

Anaconda distribution comes with 1,500 packages selected from PyPI as well as the conda package and virtual environment manager. It also includes a GUI, Anaconda Navigator, as a graphical alternative to the command line

interface (CLI). A Jupyter Notebook document is a JSON document, following a versioned schema, and containing an ordered list of input/output cells which can contain code, text mathematics, plots and rich media, usually ending with the ". ipynb" extension.

Tensor Flow

Tensor flow is a free and open-source software library for dataflow and differentiable programming across a range of tasks. It is a symbolic math library, andis also used for machine learning applications such as neural networks. It is used forboth research and production at Google.

Keras

Keras is an open-source neural-network library written in Python. It is capable of running on top of TensorFlow, Microsoft Cognitive Toolkit, R, Theano, or Plaid ML. Designed to enable fast experimentation with deep neural networks, it focuses on being user-friendly, modular, and extensible. Keras contains numerous implementations of commonly used neural-network building blocks such as layers, objectives, activation functions, optimizers, and a host of tools to make working with image and text data easier to simplify the coding necessary for writingdeep neural network code.

Open Cv

OpenCV (Open source computer vision) is a library of programming functions mainly aimed at real-time computer vision. Originally developed by Intel, it was latersupported by willow garage then Itseez (which was later acquired by Intel). The library is cross platform and free for use under the open source BSD license. OpenCVsupports some models from deep learning

frameworks like TensorFlow, Torch, PyTorch (after converting to an ONNX model) and Caffe according to a defined listof supported layers. It promotes Open Vision Capsules. which is a portable format, compatible with all other formats.

5.1.2 Hardware Configuration

- Processor: Intel core i5 or above.
- 64-bit, quad-core, 2.5 GHz minimum per core
- Ram: 4 GB or more
- Hard disk: 10 GB of available space or more.
- Display: Dual XGA (1024 x 768) or higher resolution monitors
- Operating system: Windows

5.2 Sample Code And Results

Importing libraries, loading data set and Open the images in dataset.

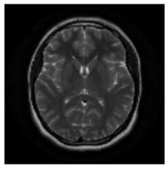
```
from sklearn.manifold import TSNE
import tensorflow as tf
from keras.models import Sequential
from keras.layers import Conv2D, MaxPooling2D
from keras.layers import Activation, Dropout, Flatten, Dense
from keras.utils.np_utils import to_categorical
```

```
Using TensorFlow backend.
```

[2]:
```
os.listdir('../input/brain_tumor_dataset')
```

[2]:
```
['no', 'yes']
```

[3]:
```
im =Image.open('../input/brain_tumor_dataset/no/1 no.jpeg').resize((128,128))
im
```

[3]:


Extracted the features from images and after extracting the features converting the data into the normal form.

[14]:
```
len(X_data)==len(data)==len(data_target)
```

[14]:
```
True
```

[15]:
```
X = np.squeeze(X_data)
```

[16]:
```
X.shape
```

[16]:
```
(253, 32, 32, 3)
```

[17]:
```
# normalize data
X = X.astype('float32')
X /= 255
```

Applying the CNN layers into the model.

[21]:
```
model = tf.keras.Sequential()

# Must define the input shape in the first layer of the neural network
model.add(tf.keras.layers.Conv2D(filters=16,kernel_size=9, padding='same', activation='relu', input_shape=(32,32,3)))
model.add(tf.keras.layers.MaxPooling2D(pool_size=2))
model.add(tf.keras.layers.Dropout(0.45))

model.add(tf.keras.layers.Conv2D(filters=16,kernel_size=9,padding='same', activation='relu'))
model.add(tf.keras.layers.MaxPooling2D(pool_size=2))
model.add(tf.keras.layers.Dropout(0.25))

model.add(tf.keras.layers.Conv2D(filters=36, kernel_size=9, padding='same', activation='relu'))
model.add(tf.keras.layers.MaxPooling2D(pool_size=2))
model.add(tf.keras.layers.Dropout(0.25))

model.add(tf.keras.layers.Flatten())

model.add(tf.keras.layers.Dense(512, activation='relu'))
model.add(tf.keras.layers.Dropout(0.15))


model.add(tf.keras.layers.Dense(1, activation='sigmoid'))

# Take a look at the model summary
model.summary()
```

Training the Dataset

[23]:
```
model.fit(x_train,
          y_train,
          batch_size=128,
          epochs=150,
          validation_data=(x_valid, y_valid),)
```

```
Train on 190 samples, validate on 63 samples
WARNING:tensorflow:From /opt/conda/lib/python3.6/site-packages/tensorflow/python/ops/math_ops.py:3066: to_int32 (from tensorflow.python.ops.math_op
is deprecated and will be removed in a future version.
Instructions for updating:
Use tf.cast instead.
Epoch 1/150
190/190 [==============================] - 1s 7ms/sample - loss: 0.6658 - acc: 0.4421 - val_loss: 1.4283 - val_acc: 0.0000e+00
Epoch 2/150
190/190 [==============================] - 1s 4ms/sample - loss: 0.5241 - acc: 0.8158 - val_loss: 0.9885 - val_acc: 0.0000e+00
Epoch 3/150
190/190 [==============================] - 1s 4ms/sample - loss: 0.4745 - acc: 0.8158 - val_loss: 0.8480 - val_acc: 0.0000e+00
Epoch 4/150
190/190 [==============================] - 1s 4ms/sample - loss: 0.4916 - acc: 0.8158 - val_loss: 0.9366 - val_acc: 0.0000e+00
Epoch 5/150
190/190 [==============================] - 1s 4ms/sample - loss: 0.4543 - acc: 0.8158 - val_loss: 1.1954 - val_acc: 0.0000e+00
Epoch 6/150
190/190 [==============================] - 1s 4ms/sample - loss: 0.4645 - acc: 0.8158 - val_loss: 1.2009 - val_acc: 0.0000e+00
Epoch 7/150
190/190 [==============================] - 1s 4ms/sample - loss: 0.4535 - acc: 0.8158 - val_loss: 1.0090 - val_acc: 0.0000e+00
Epoch 8/150
190/190 [==============================] - 1s 4ms/sample - loss: 0.4480 - acc: 0.8158 - val_loss: 0.9432 - val_acc: 0.0000e+00
Epoch 9/150
190/190 [==============================] - 1s 4ms/sample - loss: 0.4503 - acc: 0.8158 - val_loss: 0.9645 - val_acc: 0.0000e+00
Epoch 10/150
190/190 [==============================] - 1s 4ms/sample - loss: 0.4396 - acc: 0.8158 - val_loss: 1.0183 - val_acc: 0.0000e+00
Epoch 11/150
190/190 [==============================] - 1s 4ms/sample - loss: 0.4388 - acc: 0.8158 - val_loss: 1.0554 - val_acc: 0.0000e+00
```

Testing the Dataset

[25]:
```
# Evaluate the model on test set
score = model.evaluate(x_test, y_test, verbose=0)

# Print test accuracy
print('\n', 'Test accuracy:', score[1])
```

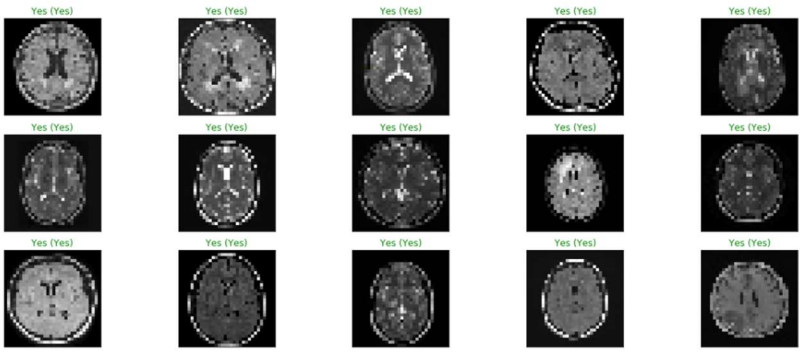
```
Test accuracy: 0.6984127
```

+ Code + Markdown

[26]:
```
labels =["Yes",  # index 0
         "No",       # index 1
         ]
```

Output Result:

```
# Plot a random sample of 10 test images, their predicted labels and ground truth
figure = plt.figure(figsize=(20, 8))
for i, index in enumerate(np.random.choice(x_test.shape[0], size=15, replace=False)):
    ax = figure.add_subplot(3, 5, i + 1, xticks=[], yticks=[])
    # Display each image
    ax.imshow(np.squeeze(x_test[index]))
    predict_index = np.argmax(y_hat[index])
    true_index = np.argmax(y_test[index])
    # Set the title for each image
    ax.set_title("{} ({})".format(labels[predict_index],
                                  labels[true_index]),
                                  color=("green" if predict_index == true_index else "red"))
plt.show()
```



5.3 Performance Measures:

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

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

$$Specificity = \frac{TN}{TN + FP}$$

$$Sensitivity = \frac{TN}{TP+FN}$$

5.4 Performance Evaluation:

On experimentation, it was observed that the proposed methodology seems to be outperformed when compared to all different set of images. Among all the images, the proposed Convolutional Neural Network (CNN) based approach seems too much better in terms of quality of the output in 128 *128 images when compared to its other sized images which are represented in table and charts.

TABLE 1 Represents the true positive, true negative, false positive and false negativevalues of the proposed approach for different set of images.

Different set of Images	True Positive (%)	True Negative (%)	False Positive (%)	False Negative (%)
128 * 128 Images	83.7	84.5	16.3	15.5
256 * 256 Images	82.4	84.1	17.6	15.9
512 * 512 Images	82.1	83.7	17.9	16.3

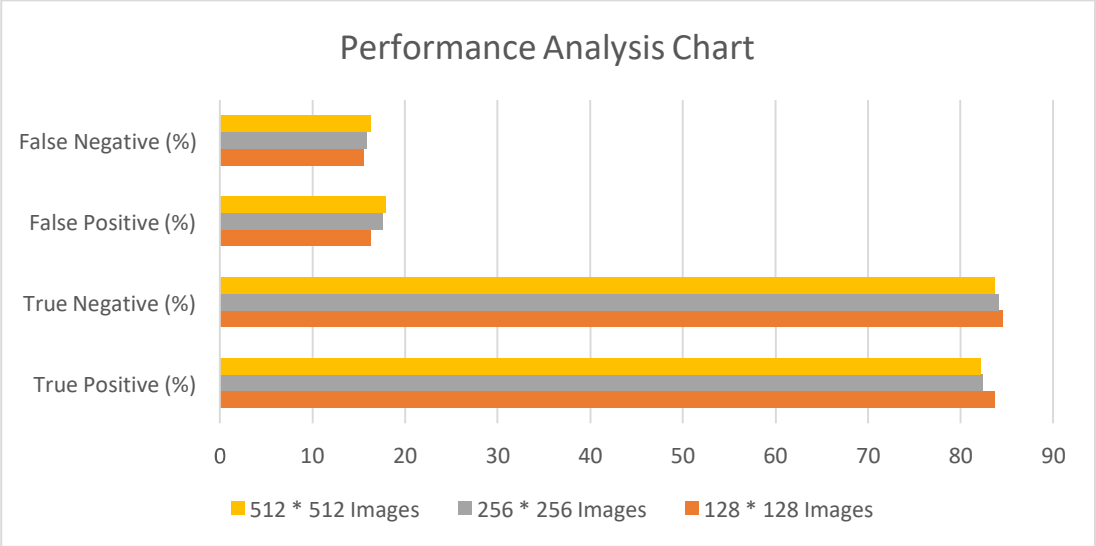


Fig. 5.1 Represents the performance analysis of CNN

It is observed from table 2 upon performing proposed segmentation technique for different set of images that have the ability to recognize the isolated region from theMR images that are used to analyze the shape and size of the denoised image. We haveused Convolutional Neural Network (CNN) for segmentation, and the output of our proposed work is pleased with better accuracy, sensitivity, and computational time.

TABLE 2 Represents the Accuracy, Sensitivity, and Specificity of the proposedapproach for different set of images.

Different set of Images	Accuracy (%)	Sensitivity (%)	Specificity (%)
128 * 128 Images	**84.1**	**84.4**	**83.8**
256 * 256 Images	**83.3**	**83.4**	**82.7**
512 * 512 Images	**82.9**	**83.3**	**82.4**

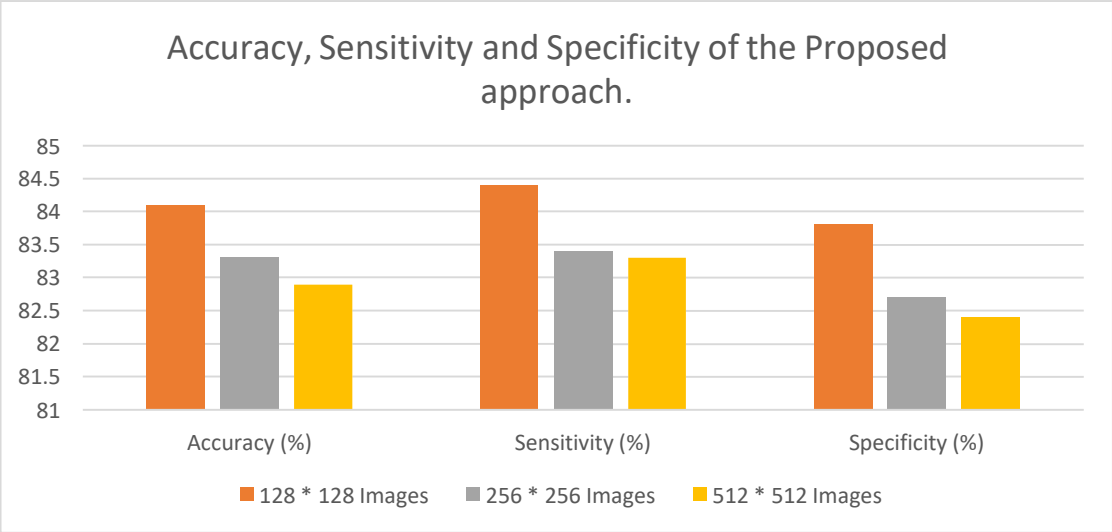


Fig. 5.2 Represents the performance of proposed CNN

Chapter 6

Conclusion and Future Scope

6.1 Conclusion:

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

6.2 Future Scope:

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

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