Convolution Neural Network With GLCM Approach for Brain Tumor Detection

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***Abstract*—** A complex human body organ that consists of innumerable neurons is known as brain. There are a large number of cells in a brain and each cell performs a different task. To ensure the appropriate functioning of human body, most of the cells generated in the body portion generate new cells. Benign and malignant are the two kinds of tumors that are commonly found in humans. The tumors that can cause the possibility of affecting other healthy brain tissues are called the benign tumors. The tumors that grow outside the brain and are also known as brain cancer are called the malignant tumors. In this research work, Convolution Neural Network (CNN) is used for the brain tumor detection. The CNN algorithm gives high performance in terms of accuracy, specificity and sensitivity.

Keywords— CNN, Brain Tumor, Sensitivity, Specificity, MRI, MIP, TDNN

I. INTRODUCTION

A brain tumor is a group or mass of abnormal cells in the brain. The skull is very rigid in which the brain is enclosed. There are various issues occurred due to growth of any tumor inside this restricted space. The malignant and benign are two main categories of the brain tumor. The skull is pressurized to enlarge from inside in case of growth of any benign or malignant tumor. This tumor leads to brain damage and it can be dangerous to life also. The brain tumor is divided into two kinds - primary or secondary. The tumor which occurs in the brain is known as primary brain tumor. A number of brain tumors are benign. A secondary brain tumor is also metastatic brain tumor. This tumor originates due to spreading of cancer cells spread in the brain from another organ in which lung or breast is included. The brain tumors can begin in the brain or cancer can begin in rest of the parts of the body. It can spread to the brain. The growth rate and the position of a brain tumor investigate its impacts on the function of nervous system. The kind of brain tumor and also its size and location have assisted in prescribing the treatment options of brain tumor [1]. At Present, digital images have tremendously influenced and impacted modern society in multiple ways. Digital Image Processing (DIP) has emerged as a vital tool in science and technology. The whole arena of digital image processing with different techniques has shown its applicability to the study of medicine. The popular term "Medical Image Processing" represents the use of digital image processing for medical applications. MRI or Magnetic Resonance Imaging is an advanced medical imaging approach. This approach delivers important information regarding the anatomical structure of human soft tissues. This algorithm is more advantageous than its counterparts since it offers 3D (three-dimensional) data with high contrast amongst soft tissues. In recent times, detection and classification of brain tumor is a popular research field in MIP (Medical Image Processing). The manual way of brain tumor detection by doctors is extremely tricky and needs plenty of time. Hence, automatic brain tumor detection and classification needs to be implemented for avoiding miss-classification and saving time. In the midst of various imaging methods, the use of MRI is quite prevalent for brain tumor detection due to its high resolution, good capability to highlight change.

The partition of a photo is carried out into a number of parts during segmentation. Image segmentation refers to the process of dividing a digital picture into many parts. This process is generally used to locate image objects and edges for making image analysis simpler [8]. In this process, a label is assigned to every image pixel. Also, pixels with similar label have some common visual features. The selection of an image segmentation algorithm relies on the features to be conserved and retrieved. Several image segmentation methods are described below:

A. Threshold-based Segmentation

Thresholding is one of the simplest approaches of image segmentation. These methods partition the image pixels on the basis of their intensity level. Threshold segmentation is a very popular segmentation technique in region-based segmentation algorithms. The main objective of this approach is to robotically determine the optimal threshold based on a certain criterion, and use these pixels according to Gray level for cluster analysis.

B. Local Thresholding

This scheme approach selects local threshold levels by splitting a picture into many sub-pictures. Further, threshold value of all parts is measured separately. On contrary to global thresholding, this process takes a lot of time. This scheme provides satisfactory results and orients backdrop. This scheme is just adequate for extracting of smaller regions.

C. Adaptive Thresholding

In many situations, gray level remains instable and the intensity of the image changes regularly. This happens due to

the lack of same threshold in every region. This issue can be resolved by using a grey threshold level. This is a gradually revolving function of image position. This approach uses lots of threshold values for several local areas.

D. Edge-based Segmentation

The edge-based segmentation methods are based on the rapid change of intensity value in an image because a single intensity value does not provide good information about edges [9]. Edge detection techniques locate the edges where either the first derivative of intensity is greater than a particular threshold or the second derivative has zero crossings. In edge-based segmentation methods, first of all the edges are detected and then are connected together to form the object boundaries to segment the required regions.

E. Gradient-based Segmentation

This scheme pays heed to the difference amidst the intensity level of related pixels. When an infrequent alteration within an image occurs, the level of noise within that image becomes extremely low. This scheme applies gradient operators in the image

F. Watershed Segmentation

Watershed segmentation is an example of region-based segmentation. This approach makes use of image morphology. In any case, this algorithm needs to select one marker within every image object, such as the background as a distinct object. In general, an operator selects the markers. Sometimes, an automated process considering application-based information of the objects selects marker. After the marking of objects, a morphological watershed transformation is applied for their growth.

II. LATERATURE REVIEW

Shrutika Santosh Hunnur, et.al (2017) analyzed that one of the parts of the image processing in medical field was the processing of MRI that was the most promising field from last few days [16]. In the initial stage, the tumor was detected. The thresholding technique was suggested for the detection of the brain tumor. The suggested method was implemented in effective way for detecting and extracting the brain tumor from magnetic resonance images which were taken from the database of patient. It was demonstrated as helpful tool for the physicians who worked in this field.

Mircea Gurbină, et.al (2019) described that the CWT, DWT and Support Vector Machines were utilized to execute a system of the brain tumor detection and prevention [17]. The recommended technique was employed for differentiating the between the benign or malign. The MRI of brain was implemented to study some kinds of brain tumors in which metastatic bronchogenic carcinoma tumors, glioblastoma and sarcoma were comprised. Various wavelet transforms and SVM were carried out for detecting and classifying the brain tumors of magnetic resonance images. The accurate and automated classification of MRI brain images was very essential for medical analysis and interpretation.

Shrutika Santosh Hunnur, et.al (2017) studied that one of the parts of the image processing in medical field was the processing of MRI that was the most talented field from last few days [18]. In the primary step, the detection tumor was performed. The thresholding technique was suggested for the detection of the brain tumor. The presented method was implemented in effective way for detecting and extracting the brain tumor from magnetic resonance images which were taken from the database of patient. It was demonstrated as helpful tool for the physicians who worked in this field.

Mahesh Swami, et.al (2020) presented a hybrid algorithm on the basis of image processing and segmentation to process a radiograph CT and MRI images so that the brain tumor detection was performed [19]. Google open source brain scans were utilized to obtain the database and MATLAB v2019 was implemented to construct the system for Windows. At first, image processing was summarized for medical imaging in this work. In the engineering analysis, it was demonstrated that this algorithm had obtained 100% sensitivity, 89.66% similarity and 87.50% accuracy. The formation of a cost-effective system that was accessible to medical practitioners on everyday computers had suggested in this work.

Parveen, et.al (2015) recommended a novel hybrid method which was planned on the basis of SVM and FCM to classify the tumor [20]. The SVM was integrated with the FCM and a hybrid method in the recommended algorithm to forecast the brain tumor. The contrast improvement and mid-range stretch were improvement methods that had employed to improve the image in this algorithm. The skull striping was performed applying double thresholding and morphological operations. The image was segmented with the deployment of FCM clustering so that the suspicious area was detected in MRI image of brain. The GLRLM was carried out for extracting the attribute from the brain image. Later on, the Support Vector Machine was implemented for the classification of the MRI images of brain and the accurate and more effectual outcome had obtained to classify the of MRI images of brain.

T. M. Shahriar Sazzad, et.al (2019) suggested an automated approach in which the brain tumor was detected by integrating MRI gray-scale images [21]. An automated approach was suggested in this study that comprised enhancement at the preliminary phase for minimizing the gray-scale color variations. The unwanted noises were eliminated using filter operation as much as possible for assisting superior segmentation. The OTSU segmentation based on threshold was carried out as a substitute of color segmentation because of the testing of grayscale images in this study. At last, the attribute information was offered by pathology experts. This information was carried out for recognizing ROI. It was

indicated in the results of experiments that the suggested approach had potential to provide superior performance in comparison with existing available approaches with respect to accuracy while maintaining the acceptable accuracy rate of pathology experts.

Mahesh Kurnar, et.al (2018) analyzed that the one of the well-known research areas was segmentation of brain tumor in MRI in the field of medical imaging system [22]. It was highly important to detect brain tumor so that its exact size and position could be determined. This paper suggested K-means clustering algorithm to detect the tumor on the basis of segmentation and morphological operation. First of all, pre-processing of MRI scanned image was performed. Afterward, the image was subjected to the K-means clustering. The morphological operator was implemented for extracting the tumor in the pre-processed MRI scanned image. At last, the area of extracted tumor part was computed.

A Reema Mathew, et.al (2017) emphasized on suggesting and executing a well-organized system to detect and classify tumor [23]. The image preprocessing for noise removal, feature extraction, segmentation and classification were various stages comprised in this work. The anisotropic diffusion filters were utilized to pre-process the magnetic resonance image of brain. The attributes based on DWT were extracted during the feature extraction stage. The extracted features were provided as input in the segmentation phase. The tumor was segmented and classified using SVM.

Luxit Kapoor, et.al (2017) studied that the fundamental purpose of medical imaging was significant to be taken out correct info from obtained scans with good accuracy [24]. The Magnetic Resonance Image was one of the most reliable and safe among several kinds of medical imaging processes. The exposure of body was not included in it to any sorts of harmful radiation. Later on, the processing of MRI was done and the tumor was segmented. The utilization of numerous diverse methods was comprised in the segmentation of tumor. The entire procedure for the detection of brain tumor from an MRI was divided into four diverse categories. The research done by other professionals was reviewed in this survey and compiled into one paper.

Digvijay Reddy, et.al (2018) described that the dicom MRI was obtained as an input and utilized for extracting tumor cells from the input image [25]. The noise was eliminated from an image using pre-processing method. The k-means clustering was carried out to this image. The morphological operations were utilized eliminate the skull from this clustered image so as the tumor cells were recognized easily. At last, thresholding was implemented to this image and then level set segmentation was employed for extracting the tumor cells. The TP, TN, FP, recall and FN were various performance metrics that had computed so as the accuracy of the outcomes was quantified.

M. H. O. Rashid, et.al (2018) discussed that the MRI image of brain was selected for the investigation and a technique was proposed for more clear view of the location attacked through tumor [26]. This technique utilized the MRI abnormal brain images as input, Anisotropic filtering to eliminate the noise, SVM classifier to the segmentation and morphological operations to separate the affected region from normal region were the main stages of the proposed technique. The base of this technique was to obtain clear MRI images of the brain. The tumor was recognized while classifying the intensities of the pixels on the filtered image. The outcomes obtained from experiments proved that the accuracy acquired from the Support Vector Machine was evaluated 83% during segmentation. At last, the segmented region of the tumor was used in the original image for a distinct identification.

III. RESEARCH METHODOLOGY

This work aims to devise a new algorithm for brain tumor detection. First of all, MR scans are used as input. Then, region-based segmentation with a classification algorithm is applied on these scans so that the brain tissues can be classified into normal and abnormal. This applies k-mean clustering and CNN for segmentation and classification respectively. The approach of CNN will be applied which can categorize and localize the cancer part. CNNs represent a subcategory of the discriminative deep architecture. This algorithm efficiently performs the processing of two-dimensional data with grid-shape topology, such as images and videos. The architecture of CNNs is based on the animal visual cortex organization. The concept of CNNs is based on TDNNs (Time-Delay Neural Networks). In a TDNN, the sharing of weights is carried out in a temporal dimension to reduce the computation. In these networks, the convolution has taken the place of general matrix multiplication in normal neural networks. This leads to the reduction in number of weights also the complexity of the network. CNNs are the initial completely effective deep learning architecture because of the efficacious training of the hierarchical layers. The CNN topology promotes spatial relationships for reducing the number of network parameters and uses standard back propagation algorithmic approaches for improving the network performance.

CNN model requires minimum pre-processing and this is the one more benefit of this approach. Three factors called sparse interaction, parameter sharing and equivariant representation contribute significantly in the learning process of a CNN. CNNs decrease the computational load with sparse interaction. In order to do so, the size of kernels is made lesser than the inputs and used for the complete image. The parameter sharing is based on the concept that there is the need to learn just one set of them indicating better performance of the CNN rather than learning a distinct set of parameters at every place. Therefore, CNN needs lesser number of parameters as compared to the other conventional NN algorithms, which reduces memory usage and improves efficiency. The elements of a standard CNN layer are described in figure 1 sketched below:

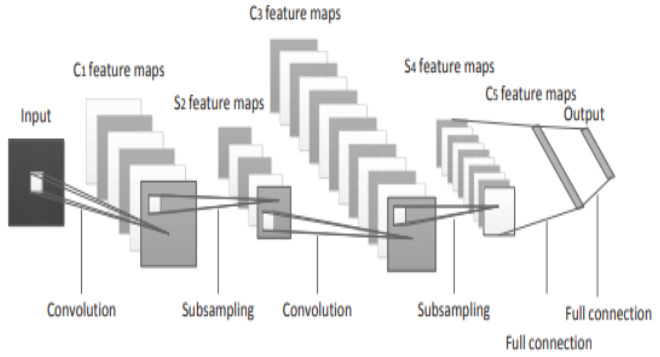
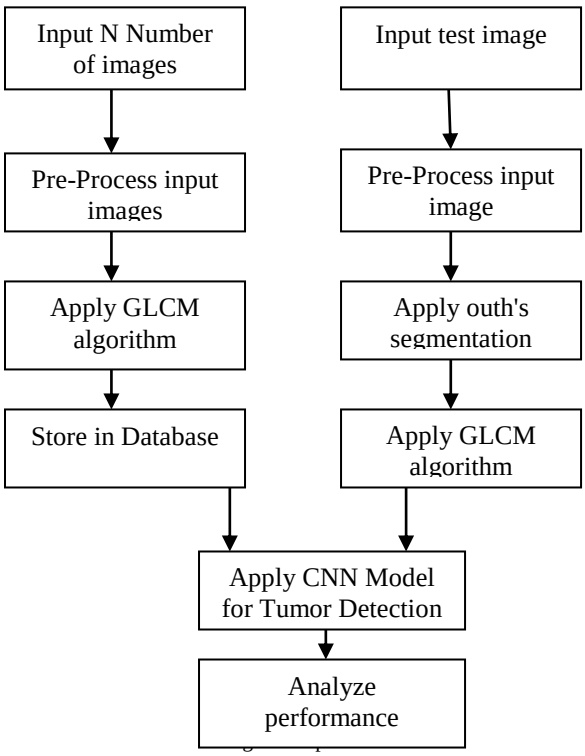


Fig. 1: Schematic Structure of CNNs

As shown in figure 1, a CNN is a multi-layer neural network that comprises different sorts of layers. These layers are called Convolution Layers (C-Layers) and Sub-Sampling Layers (SS-Layers). C-Layers and SS-Layers are linked interchangeably and create the middle part of the network. In order to generate feature maps in the first C-Layer, the convolution of input image is performed by trainable filters at all feasible offsets. Every filter includes a layer of connection weights. Generally, a group is formed by four pixels in the feature map. These pixels generate extra feature maps in the first S-Layer after passing through a sigmoid function. This process remains continue and the feature maps in the subsequent C-Layers and S-Layers are obtained. At last, the values of these pixels are rasterized and demonstrated in a single vector as the network input.



This research work is based on the brain tumor detection. Each phase is explained below:-

Step 1:- Input Images:- In the first phase N number of images are taken as input for the training set. The images are collected from the authentic source which is kaggle for the brain tumor detection

Step 2: Apply Segmentation:- In this research work, the outh's segmentation technique is applied for the image segmentation. Binary pictures are created from grey-level pictures by applying thresholding. Under this process, some pixels are set beneath some threshold to zero though some pixels greater than that threshold to one. The diseased leaf displays the indications of the infection by varying the color of the leaf. Therefore, it is possible to use the greenness of the leaves for detecting the unhealthy part of the leaf. From the picture, R, G and B elements are extracted. This algorithm can be deployed for calculating threshold. When the green pixel brightness is below the quantified threshold then masking and removal of the green pixels is done.

Step 3: Apply GLCM Algorithm:- In this phase GLCM algorithm is applied for the feature extraction of input image. The textural attribute is analyzed with the utilization of GLCM algorithm in order to test the texture in statistic manner. The function of this algorithm distinguishes the texture of an image. The Gray-level co-occurrence matrix algorithm is generated by evaluating the specified spatial association with the derivation of pixel pairs in an image. Additionally, the extraction of statistical measures is carried out from the produced matrix in the next stage. This algorithm is implemented to set the gray co-matrix function on MATLAB. This algorithm allows the chances of occurrence of an intensity value denoted with 'i' in the specific spatial association to a pixel having value j.

Step 4:- In the last step technique of CNN is applied for the tumor type detection. In this step the performance is analyzed in terms of accuracy, sensitivity and specificity.

IV. RESULT AND DISCUSSION

MATLAB software is generally used for performing complicated mathematical calculations. This simulation software makes use of simplified C a programming language. The software includes a series of inbuilt toolboxes. This software is used to serve different purposes. Some popular applications include algorithm implementation, graph plotting and designing of user interfaces. The software contains high graphics which makes it suitable for network simulation. MATLAB helps to analysis the accuracy, sensitivity and specificity of the proposed system.

Execution Time: As per equation (1), it corresponds to the difference amid end and starting time of algorithm.

$$\text{Execution Time} = \text{End time of algorithm} - \text{Start of the algorithm} \quad (1)$$

Table 1: Performance Analysis

Accuracy	Sensitivity	Specificity
92 percent	93 percent	94.5 percent

As shown in table 1, the various performance of the CNN model is analyzed in terms of accuracy, sensitivity and specificity.It is analyzed that in terms of all parameters performance is above 90 percent

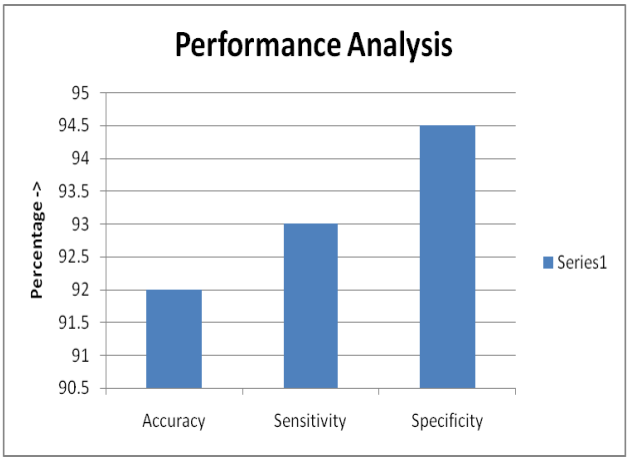


Fig 2: Performance Analysis

V. CONCLUSION

The existing approaches of brain tumour detection have several issues. This aspect generates the need of a new algorithmic approach with accuracy good and minimum execution time. Initially, the MR scans are made noise free by applying median filtering approach. Then, image segmentation is performed using threshold-based segmentation. This approach extract skull area from the MR scan. After that, Gray-Level Co-Occurrence Matrix (GLCM) is implemented for extracting features. Eventually, ML algorithms are used for detecting and classifying and categorization of tumorous area. The new scheme makes use of Computer Vision and Machine Learning toolbox. This approach is applied in MATLAB. Finally, the comparison of new and existing algorithms is carried out on the basis of some metrics.

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