Comparative study of Convolution Neural Network with GLCM Approach and Superpixel based spectral clustering for Brain Tumor Detection

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Abstract **- Extensive growth in the volume of irregular brain cells is known as brain tumor. Human brain is surrounded by stiff skull. There are various issues that occur due to the 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 harm in brain and it may be dangerous to life also. The brain tumor is divided into two kinds - primary or secondary. The brain tumor detection techniques have various phases. In this paper, comparative study of CNN with GLCM approach and superpixel based spectral clustering is done tumor. This work takes into account metrics like accuracy, sensitivity and specificity for drawing the comparison between both the techniques.**

Index Terms **- CNN, Brain tumor, GLCM, Segmentation, superpixel, spectral clustering.**

I.INTRODUCTION

Extensive growth in the volume of irregular brain cells is known as brain tumor. Human brain is surrounded by stiff skull. There are various issues that occur due to the 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 harm in brain and it may be dangerous to life also. Brain tumors are generally divided into two categories of primary and secondary. A number of such tumors are non-cancerous (benign). Secondary tumors, on the other hand, originate due to the spreading of cancerous cells in the cerebrum from other body organs. These tumors can spread to rest of the body areas. It can spread to the brain even. 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. At Present, digital images have tremendously influenced and impacted modern society in multiple ways. Digital image processing has emerged as a vital tool in science and technology. The procedure of brain cancer detection is categorized generally into four phases after the selection of MRI pictures. These phases include preprocessing, segmentation, feature extraction and classification or clustering. A block diagram describing the above four stages is presented in the Figure 1.

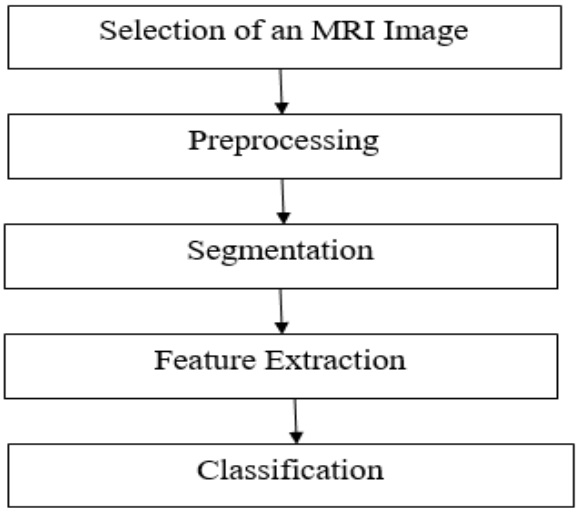

Figure 1: Crucial steps for detecting brain tumor

The quality of the brain images can be improved by applying different image preprocessing techniques. In segmentation process, an image is segmented in different regions. Superpixel based spectral clustering is one of the techniques for image segmentation. In this technique, the ROI that contains information of timorous tissue is segmented using spectral clustering rather than considering the whole image. The data

reduction is performed using superpixels. After image segmentation, feature extraction is to be done to extract the pattern of assessable characteristics or features of the image. Different features i.e. statistical, texture, on the basis of color and image, etc. are extracted. Classification methods are executed for classifying affected and non-affected pictures of the brain [2]. These methods identify whether the abnormality present in the anomalous pictures is of malignant (cancerous) or benign (non-cancerous) type. After tumor segmentation, features are extracted from the segmented image for determining whether the tumor is low grade or high grade. There are various tumor features such as shape, size etc. which can differentiate between different tumor grades. Tumor with high grade shows more irregularity. Some popular methods of feature extraction are: Feature extraction from brain MR images using wavelets is considered as finest approach that highlights pixels in images for better results. Discrete wavelet transform (DWT) implements wavelet transform by means of a discrete group of the wavelet scales and conversions following predefined principles. In another way, this transform does the decomposition of the signal into equally orthogonal wavelet group [11]. GLCM is a prominent texture-based algorithm for extracting features. This algorithm performs an operation on the images on the basis of second-order statistics to locate textural relationship between pixels. On the whole, this operation is performed using two pixels. GLCM algorithm finds out the frequency of combinations of these pixels' intensity levels.

II.LITERATURE 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 to diagnose tumor within brain. The suggested method was implemented in effective way for detecting and extracting the tumorous area from MR scans 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. Various wavelet transforms and SVM were carried out for detecting and classifying the brain tumors of magnetic resonance images. It was essential to classify MR scans accurately and automatically for clinical inspection and understanding.

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 suggestedto diagnose tumor within brain. The presented scheme was implemented in effective way for detecting and extracting the tumorous area from MR scans 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 profitable and easy to use scheme for physicians 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, SVM was implemented to classify MR scans of brain and the

accurate and more effectualoutcome had obtainedat the last.

T. M. Shahriar Sazzad, et.al (2019) suggested ancomputer assisted scheme 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 to segmentbrain tumor in the field of medical imaging system [22]. Brain tumor detection was very valuable for discovering the correct size and location of tumor. This paper suggested K-means approach to detect the tumorous area on the basis of segmentation and morphological operation. First of all, pre-processing of MRI scanned image was performed. Afterward, the image was transferred for clustering using K-means. The morphological operator was implemented for extracting the tumor. At last, retrieved tumorous area was computed.

A Reema Mathew, et.al (2017) emphasized on suggesting and executing a well-organized system so that the tumorous area can be diagnosed and classified [23]. All steps of image processing were 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 in feature extraction stage. The taken-out attributes were provided in form of input in the next phase of segmentation. The tumor was segmented and classified using SVM.

Luxit Kapoor, et.al (2017) studied that the fundamental purpose of medical imaging was the significant and accurate information was extracted from these images with the least error possible [24]. The Magnetic Resonance Image was one of the highly-trustworthy and secure among several kinds of clinical imaging methods. 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 tumor from an MR scan 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 to taken out abnormal brain cells [25]. The denoising of medical image was carried out by applyingdifferent techniques of pre-processing. Further, image clustering was performed using k-means approach. The morphological operations were utilized eliminate the skull from this clustered image so as the tumor cells were recognized easily. Finally, thresholding was applied to this medical scan and then level set segmentation was employed for extracting the abnormal tissues. 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 do a comparative study of CNN using GLCM approach and superpixels based spectral

clustering for brain tumor detection. First of all, MR scans are used as input. Then, threshold-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 Otsu's threshold technique 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 data in dual size by means of grid-shape topology. The design of CNNs is based on the animal visual cortex. The CNNs is based on TDNNs. InTDNN, the sharing of weights is carried out in a time-based size to reduce the calculation. 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 design promotes spatial relations 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.

On the other hand, supepixels based spectral clustering techniques detects the tumor area by applying spectral clustering for segmentation. In this technique, ROI that contains information of timorous issue is segmented using spectral clustering rather than considering the whole image. The data reduction is performed using superpixels are generated using Central Tendency Value (CTV) of blocks of the image. These superpixels are considered as nodes for spectral clustering to identify ROI. As the result of segmentation of supepixels, tumor supepixels and non-tumor superpixels ae obtained. The original block of tumor superpixel in the image is denoted as tumor block. The adjacent blocks similar to the tumor block are extracted using Local Binary Pattern (LBP) feature extraction techniques to form ROI. Lastly, the ROI is segmented using spectral clustering to represent various tumour tissues.

The figure 2 here shows the flow chart of the proposed methodology.

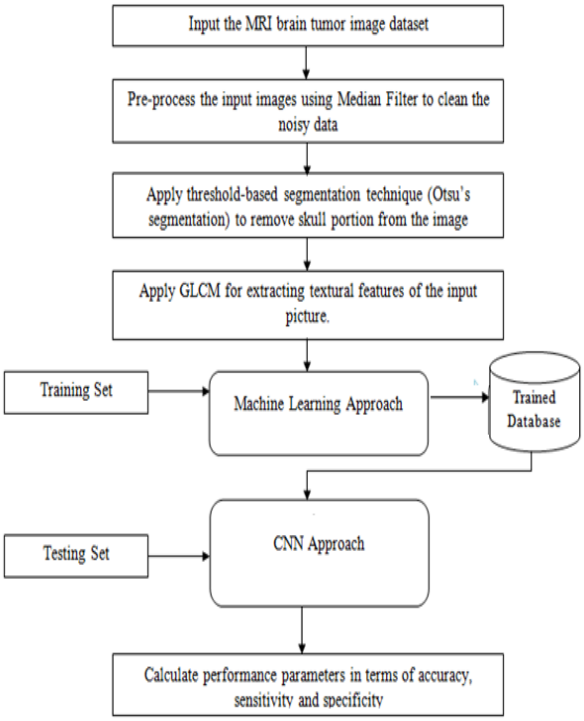

Figure 2: Proposed Methodology

IV.COMPARISON AND RESULTS

The online dataset is taken for drawing the comparison between both the techniques. The MRI images are being considered. It is found that people are diagnosed with specific types of brain tumor. They are having malignant tumor and are without surgery. The data were taken from the Midnapur Diagnostics Private Limited at R. G. Kar Medical College and Hospital, Kolkata (West Bengal). From the entire database 20 MRI images have been searched in which the Brain Tumor is clearly visible. After taking the data set, comparative study is done and various metrics like accuracy, specificity and sensitivity are compared for both the techniques.

The formulas for the above mentioned parameters are:

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

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

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

Where TP denotes True Positive, TN denotes True Negative, FP denotes False Positive and FN denotes False Negative.

The comparison graph is shown below:

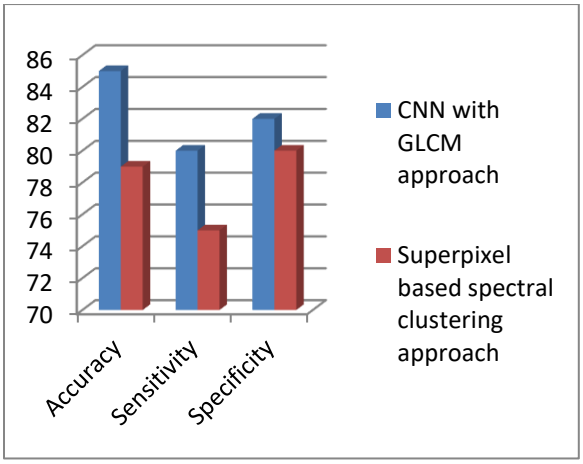

Figure 3: Comparison graph for the techniques

In the graph, it is shown that CNN with GLCM approach gives average accuracy of 85 percent when the whole dataset is considered whereas superpixel based spectral clustering shows average accuracy of 79 percent. Similarly, the CNN approach also shows high values of sensitivity and specificity than spectral clustering based approach.

V.CONCLUSION

Medical image processing gains popularity due to various types of disease detection, prediction and classification. The processing and evaluation of normal as well as abnormal images is the major objective of medical image processing which helps in diagnosing the tumor affected regions from brain image dataset. In CNN with GLCM approach, the threshold-based segmentation technique will be applied for the image segmentation which remove skull from the MRI image. The textural feature extraction algorithm called GLCM will be applied for the feature extraction. For the localization and categorization of tumor region from MRI image, the machine learning algorithms will be applied in the final phase. Computer vision and machine learning toolbox are used by the proposed method when implemented in MATLAB simulator. For detecting the tumor portion, the performance of proposed and existing approaches will be compared at the end. Certain performance parameters like accuracy, specificity and sensitivity will be calculated for the comparison of the two techniques. After comparison, it is found that proposed methodology yields better results and shows high accuracy.

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