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DESIGN AND IMPLEMENTING BRAIN TUMOR DETECTION USING MACHINE LEARNING APPROACH

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Abstract – Nowadays, brain tumor detection has turned upas a general causality in the realm of health care. Brain tumor can be denoted as a malformed mass of tissue wherein the cells multiply abruptly and ceaselessly, that is there is no control over the growth of the cells. The process of Image segmentation is adopted for extracting abnormal tumor region within the brain. In the MRI (magnetic resonance image), segmentation of brain tissue holds very significant in order to identify the presence of outlines concerning the brain tumor. There is abundance of hidden information in stored in the Health care sector. With appropriate use of accurate data mining classification techniques, early prediction of any disease can be effectively performed. In the medical field, the techniques of ML (machine learning) and Data mining holds a significant stand. Majority of which is adopted effectively. The research examines list of risk factors that are being traced out in brain tumor surveillance systems. Also the method proposed assures to be highly efficient and precise for brain tumor detection, classification and segmentation. To achieve this precise automatic or semi-automatic methods are needed. The research proposes an automatic segmentation method that relies upon CNN (Convolution Neural Networks), determining small 3 x 3 kernels. By incorporating this single technique, segmentation and classification is accomplished. CNN (a ML technique) from NN (Neural Networks)wherein it has layer based for results classification. Various levels involved in the proposed mechanisms are: 1. Data collection, 2. Pre-processing, 3. Average filtering, 4. segmentation, 5. feature extraction, 6. CNN via classification and identification. By utilizing the DM (data mining) techniques, significant relations and patterns from the data can be extracted. The techniques of ML (machine learning) and Data mining are being effectively employed for brain tumor detection and prevention at an early stage.

Keywords- Abnormalities; Magnetic Resonance Imaging (MRI); Brain tumo; Pre-processing;Segmentation; feature extraction; machine learning techniques; data mining; Convolution Neural Networks.

1. INTRODUCTION

Tumor basically symbolizes abnormal and uncontrollable growth of cells within the body. Brain tumor signifies a malformed mass of tissue wherein the cells multiply abruptly and ceaselessly within the brain tissues (l).Brain tumor segmentation involves separating distinct tumor cells (effective tumor, solid, edema, and necrosis) from the normal brain cells (GM - grey matter, WM - white matter, and CSF - cerebrospinal fluid). Concerning brain tumor research, the unnatural cells tend to be explored any time [2]. The procedure of MRI doesn't involve any pain or radiation and is a non-invasive brain image process [3]. Early diagnosis and immediate treatment of brain tumor definitely increases the survival chances of an individual. Using DM techniques abundant data can be analyzed from various angles thus extracting valuable information. The research focuses on to build a diagnosis and prediction system related to brain tumor by incorporating predictive mining. Brain tumor can be related to numerous medical conditions associated with the heart. These abnormal health/medical symptoms has a direct impact on the brain. Presently, brain tumor is considered as a foremost health issue.

The research examines list of risk factors that are being traced out in brain tumor surveillance systems. Also the method proposed assures to be highly efficient and precise for brain tumor detection, classification and segmentation. For these reasons, accurate semi-automatic or automatic methods are required. To achieve this precise automatic or semi-automatic methods are needed. The research proposes an automatic segmentation method that relies upon CNN (Convolution Neural Networks), determining small 3 x 3 kernels. By incorporating this single technique, segmentation and classification is accomplished. CNN (a ML technique) from NN (Neural Networks)wherein it has layer based for results classification. The research proposes a novel tumor detection technique on the basis of high level extracted features from CNNs making use of Hough transform technique. The tumors that are being detected, undergoes segmentation using a set of FC (fully connected) layers, thereafter, the segmented mask is classified via FCs. The proposed approach yields assuring outcome as per the standard medical image benchmarks. CNN (Convolutional Neural Network) or ConvNet is a deep machine learning algorithm adopted to examine the Image. It utilizes various multilayer perceptions framed to gain comparatively reduced pre -processing time. The processes involved in the proposed approach being: Data collection, Pre-processing wherein noisy data is eliminated, then comes the Average filtering which presents and identifies the clarity image and thereafter the segmentation process is employed for pixel based detection segmentation concerning the brain image and other areas being affected, next is the process of feature extraction extracts various feature such as PSNR, MEAN, Entropy, standard deviations etc... CNN via classification and identification. By utilizing the data mining techniques, significant relations and patterns from the data can be extracted. The techniques of ML (machine learning) and

Data mining are being effectively employed for brain tumor detection and prevention at an early stage.

Following represents the journal classification. Previous authors work is illustrated in Section 2. Section 3 describes the proposed machine learning (ML) approach for detection of Brain tumor and aspects of various levels. Section 4 presents the outcome and discussion. At last, Section 5 has the conclusion along with and proposed work for future research.

2. RELATED WORK

C.Hemasundara Rao et.al, suggests an automated method for detecting and segmenting affected the brain tumor areas. There are three stages in the proposed method: 1. initial segmentation 2. Modeling of energy functions and 3. Optimizing the energy function. To achieve reliable segmentation, the information present in T1 and FLAIR MRI images are being utilized. CRF (Conditional random field) based framework is employed to merge the information existing in T1 and FLAIR in probabilistic region [4]. Atiq Islam et.al suggests using the new MultiFD (multi-fractal) feature extraction and enhanced AdaBoost classification schemes for brain tumor detection and segmentation. By making use of MultiFD feature extraction strategy, the brain tumor tissue-texture is extracted. The enhanced AdaBoost classification methods are adopted to detect if the brain tissue is tumor affected or not. The scheme exhibits high complexity [5].

Meiyan Huang et.al presents using the LIPC (local independent projection-based classification) method for classifying the voxel of the brain. Also using this method, Path feature is extracted. Explicit regularization need not be performed in LIPC. Low accuracy is achieved [6]. Bjoern H. Menze et.al, presents new brain tumor segmentation also referred to as multimodal brain tumor segmentation scheme. Various segmentation algorithm are being combined to gain better performance in contrast to the existing method. Though, still it depicts high complexity [7].

Shamsul Huda et.al presents hybrid feature selection using ensemble classification for per forming brain tumor diagnosis. For acquiring of decision rules, decision Tree, GANNIGMAC, Bagging C based wrapper approach are adopted and the decision rules are simplified by making use of hybrid feature selection that merges (Decision Tree + MRMR C + GANNIGMAC + Bagging C) [8]. Sergio Pereira et.al presents automated methods for brain tumors identifying and type cataloging by utilizing MRI images of brain right from the initial time when one could attempt to scan and freight medical images in the computer system. On the contrary, NN (Neural Networks) and SVM (Support Vector Machine) being the commonly adopted methods lately as they offer better performance [9].

J. Seetha et.al, put forth the usage of MRI images for brain tumor diagnosis. The MRI scan usually produces data in abundance which makes the manual classification process of tumor vs non-tumor very time consuming. Though it offers precise quantitative metrics for restricted no: of images. Therefore there arises a need for automated and trustworthy classification approaches to reduce the human death ratio. The automated brain tumor classification tends to be very complex in large spatial and structural inconsistency of nearby areas of brain tumor. Herein, proposed an automatic brain tumor detection approach by adopting the CNN classification [10]. N. Varuna Shree et.al, targets on noise removal technique, extraction of GLCM(gray-level co-occurrence matrix) features, brain tumor region growing segmentation (DWT-based)for minimizing the complexity and enhancing the performance. Subsequently, the morphological filtering is employed that aids in noise removal which may get build up after segmentation. The probabilistic neural network classifier is being utilized for training and testing the accuracy performance for detecting tumor location concerning the MRI images of brain [11].

Zhenyu Tang et.al, presents a new framework of MAS(Multi-atlas segmentation) for MR tumor brain images. MAS basically works by registering and fusing label information from numerous normal brain atlases into a new brain image for the process of segmentation. Mostly it is framed for normal brain images, though the tumor brain images remains a challenging concern for it. For resolving this concern, at the initial level of MAS framework, a new low-rank method is being adopted for retrieving the recovered image of normal brain from the MR tumor brain image relying upon the normal brain atlas information. In the next step, normal brain atlases are being registered for recovering the image without being affected by tumors [12].

Baljinder Singh et.al, has initially presented, the process of pre-processing wherein there is noise elimination from the images by employing fuzzy filter and a new mean shift based fuzzy c-means algorithm which requires low computing time span and offers better segmentation output in contrast to traditional techniques. The above segmentation techniques has a mean field phrase in the traditional fuzzy c-means objective function. Since it's possible for the mean shift to locate cluster centers quiet easily and promptly, all the techniques can carry out effective diagnosis of the image area [13].

GarimaSingh et.al, presents a technique to classify and analyze the image de-noising filters like the Adaptive filter, Median filter, Un-sharp masking filter, Averaging filter and Gaussian filter that are employed to eliminate additive noises prevailing within the MRI images which includes: speckle noise, Gaussian, Salt & pepper noise. PSNR and MSE are utilized for comparing the de-noising performance of all the strategies taken into account. For successful brain tumor identification, a novel idea is being recommended by making use of normalized histogram and segmentation via K-means clustering algorithm. Naïve Bayes Classifier and SVM are adopted for classifying the MRIs effectively, thereby offering precise prediction and classification [14].

G. Rajesh Chandra et.al, presents the idea of soft thresholding DWT for improvisation and genetic algorithms for the purpose of image segmentation. It's revealed that such algorithms can be implemented for grey-level magnetic resonance images. The proposed approach utilizes the potential of GA for resolving optimization issues with a large search space (which represents label of every single image pixel). Also, the proposed method integrates any prior available knowledge (like the local ground truth). The established method obtained SNR value ranging from (20 to 44) and segmentation accuracy from (82% to 97%) related to detected tumor pixels on the basis of ground truth [14].

3. PROPOSED METHODOLOGY

3.1 Project outline

Brain tumor basically symbolizes abnormal and uncontrollable growth of cells within the brain. Basically it's of two types: first being the malignant tumor that contains cancerous cells and second one is the benign tumor which doesn't have any cancerous cells. CNNs (Convolution Neural Networks)consists of multiple layers of responsive fields. The technique of Brain tumor segmentation is founded on the CNN by determining small 3 x 3 kernels. Utilization of small kernels allows for an in-depth architecture, apart from posing a positive impact in contrast to over-fitting, with minimum type of masses existing in the network. At the same time inspecting the employment of intensity normalization as a preprocessing process (which being unusual in CNN based segmentation methods). It's imbibed in combination with information segmentation, being intolerable against neoplasm segmentation concerning the magnetic resonance imaging picture.

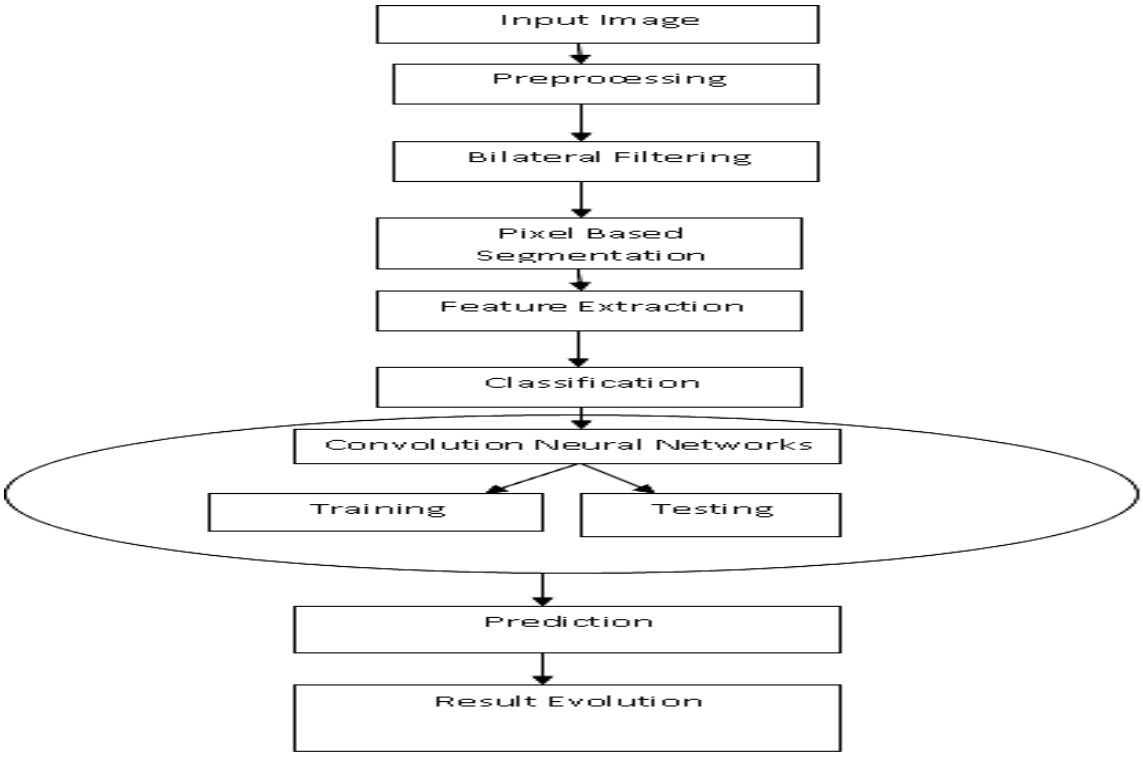


Figure 1: Overall Architecture

3.2 Brain image Preprocessing

Due to existing noise disturbance the MR images get affected. For noise reduction the research work proposes local smoothing methods and nonlocal means. In the image there may also exist few significant structures and details that can act as noise; such kind of details are also eliminated. The technique of Image pre-processing involves: data cleaning, data transformation, data integration, data resizing, data reduction etc. The image pre-processing eliminates unnecessary data and smooth up noisy data, detect and eliminate the outlier and rectify the data inconsistencies. Lastly, normalization and aggregation is performed. The technique of Image-processing proves to be highly significant in determining particular heart image, removing noise and for improvising the quality of the image.

3.3 Average filtering

The normal channel being the convolution work that is utilized to set the clamor in the images. The Pre-processing step abandons the disturbances in the image but still after applying preprocessing the image doesn't hold suitable for future process. As a result the Average channel resolves this issue by providing acceptable and smooth picture. The Average channel resembles a non-linear channel unlike straight channels. The Average channel replace the pixel esteems with an Average esteem that being nearly accessible (like, 3x3 or 5x5 or pixels near the focal pixel esteem). Moreover, Average channel tends to be edge safeguarding. It helps in abandoning salt and pepper disorder.

Algorithm:

Step 1: the picture is provided as input.

Step 2: choose a 3X3 window near the current pixelwithin the picture.

Step 3: perform pixel sorting in expanding request andsave it to vector.

Step 4: determine the normal of the vector.

Step 5: the current pixel is replaced with the normalesteem.

Step 6: Repetition of means 2 to 5 till every single pixelswithin the picture gets prepared.

Step 7: Output**.**

3.4 Pixel based segmentation

Image Segmentation is a common technique of digital image processing. Lately, Brain tumor image sectioning in MRI has spurred up as a popular research in the domain of medical imaging system. The process of Segmentation

3.7 Convolution Neural Networks

Convolutional Neural Network – CNN is employed for segmenting the images. It directly extracts features from pixel images with least pre-processing involved. The network utilized is LinkNet which being a light deep neural network architecture that's developed to carry out semantic segmentation. The LinkNet Network contains encoder and decoder blocks which basically manage to split the image and re-build again before it's forwarded via few final convolutional layers. CNN is a significant approach of deep learning which is being employed in image recognition applications. It involves two basic methods of convolution and pooling. Convolution and pooling layers are arranged till high level of classification accuracy is achieved. Moreover, few feature maps are identified in every convolutional layer and weights linked to convolutional nodes (in the same map) are being shared. Such arrangements offer comprehension of various network characteristics at the same time retaining the no: of traceable parameters. CNN possess less specific tasks in contrast to the conventional methods and helps in thoroughly extracting features. Figure 2, depicts the CNN process scheme as.

Algorithm for CNN based Classification

Step 1: convolution filter is applied in the first layer.

Step 2: The filter sensitivity is minimized by smoothingthe convolution filter that is by sub-sampling.

Step 3: The activation layer controls the signal transferfrom one layer to other layer.

Step 4: training period is being fastened by employingRELU (rectified linear unit).

Step 5: The neurons in proceeding layer is associated witheach neuron in the next layer.

Step 6:at the time of training, Loss layer is appended inthe end to provide a feedback to NN (neural network).

3.8 Evolution metrics

For performance evaluation and measuring system stability, few parameters are computed and examined. These are mentioned as:

The proposed CNNs performance is assessed with RMSE(Root Mean Square Error), recall, sensitivity, precision, F-score specificity, PME (probability of the misclassification error) and accuracy of the training and testing set and throughout performance was examined by making use of the Eqs. (1-8) correspondingly, where Y_i denotes actual and R_i denotes result of the i^{th} diagnosis of brain tumor feature acquired, TN (True Negative) denotes prediction for the patients with no brain tumor and were detected with no brain tumor, FN (False Negative) denotes the prediction for the patients with no brain tumor but were detected with a brain tumor, TP(True Positive) denotes the prediction for the patients with brain tumor and were detected with a brain tumor, and FP(False Positive) represents the prediction for the patients having brain tumor but were detected with no brain tumor.

- True Positive (TP): If the instance is positive and it is classified as positive
- False Negative (FN): If the instance is positive but it is classified as negative
- True Negative (TN): If the instance is negative and it is classified as negative
- False Positive (FP): If the instance is negative but it is classified as positive

4. RESULT AND DISCUSSION

The proposed method employs a mean field term within the standard CNN objective function. The technique is developed and applied in MATLAB environment by utilizing the image processing tool. Datasets are assembled from the UCI datasets. A comparison is portrayed among all the features and the entire result being depicted in the figures. The accuracy is computed which is then compared with rest of the state-of-arts methods. Efficiency and training accuracy of the proposed brain tumor classification approach is computed.

Table 1 illustrates the comparison of various classification techniques. It represents overall performance and comparison output in contrast to various prevailing techniques such as CRF (Conditional Random Field), SVM(Support Vector Machine) and GA (Genetic Algorithm). The proposed CNN (Convolutional Neural Network)yields in improvised output in contrast to the existing algorithms.

Table: 1 Comparison of Classification Techniques

S.No	Techniques	Accuracy(%)	Efficiency(%)
1	Conditional Random Field (CRF)	89	87.5
2	Support Vector Machine (SVM)	84.5	90.3
3	Genetic Algorithm (GA)	83.64	84.78
4	Convolutinal Neural Network (CNN)	91	92.7

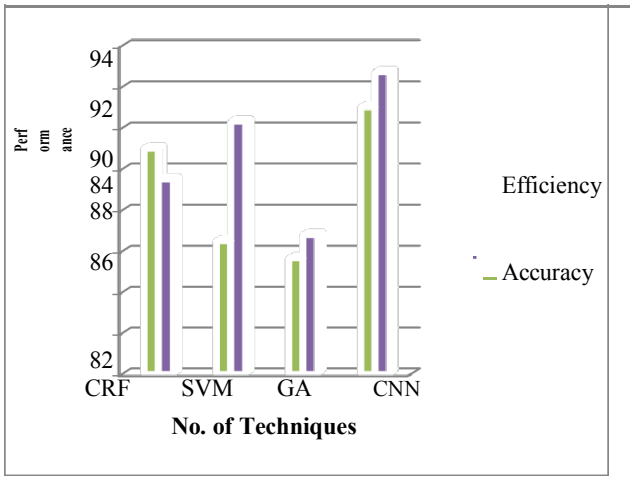
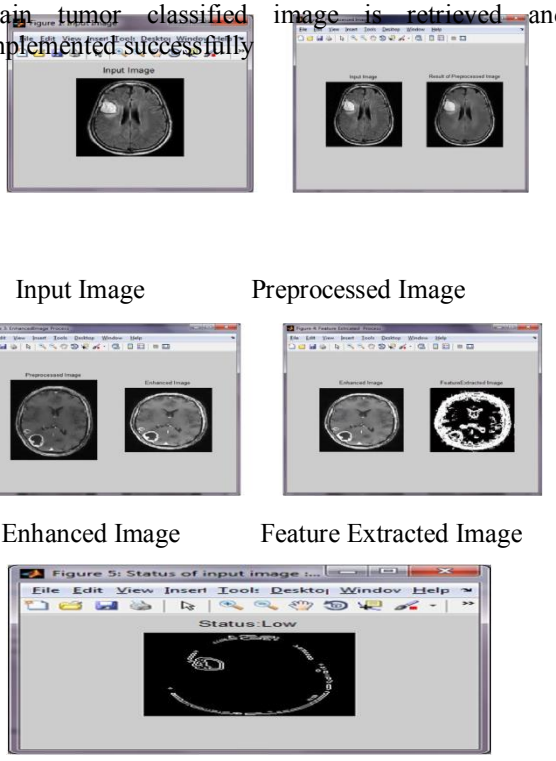


Figure: 3 Comparison graph of classification Techniques

The Figure 3 illustrates the comparison of various classification techniques. The figure represents overall performance and comparison output in contrast to various prevailing techniques such as CRF (Conditional Random Field), SVM (Support Vector Machine) and GA (Genetic Algorithm). The proposed CNN (Convolutional Neural Network)yields in improvised output in contrast to the existing algorithms.

4.2 Simulation results

The datasets are accumulated from online datasets and the MATLAB environment is used for the development process. Fig. 4 presented below depicts the overall images of brain tumor detection. Input image undergoes pre-processing depending on the testing process. Thereafter the pre-processed image is enhanced and the image is extracted. Eventually, the brain tumor classified image is retrieved and implemented successfully



Classified Image

Fig.4 Sample Output

5. CONCLUSION

Referring the earlier section, it's revealed that output generated is quiet precise and clear. Accuracy achieved at the end relies upon processing of every step. There are lot of exiting methods for every step, hence the methods that offer better results are selected. At the last, brain tumor classification takes place. To detect brain tumor detection there exist different classical approaches but the present work utilizes the traditional neural network approach for detecting brain tumor, since the brain tumor detection images relies upon the neighborhood pixels. The CNN approach provides powerful brain tumor detection. The proposed algorithm is implemented on multiple images and the output retrieved is best and effective.

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