Feature Extraction And Classification of Brain Tumor Images – A Comprehensive Survey

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Abstract- *There are various significant works have been carried out on classification of brain tumor images. Existing approaches deals different algorithms have been implemented on different dataset images. This work presents a detailed literature review of detection and classification of brain tumor images. This will help the doctors to understand the present status of brain tumor in the patient. Detection of brain tumor is the primary focus of the work and category wise classification is the secondary work. Based on the classification accuracy many of the researchers were predicted the percentage of brain tumor in the human. State of art approaches given in this paper illustrates the researchers to carry out the required work.*

I. INTRODUCTION

Brain tumor can be defined as unnatural and unrestrained growth in brain cells. Since the human skull is a rigid and volume restricted body, consequently, any unexpected growth may affect a human function according to the involved part of the brain; moreover, it may spread into other body organs and affect human functions. According to the world cancer report published by the World Health Organization (WHO), brain cancer accounts for less than 2% of human cancer; however, severe morbidity and complications are produced. Cancer Research Corporation in the United Kingdom mentioned that there are about 5,250 deaths annually by the act of brain, other Central Nervous System (CNS) and intracranial tumor in UK. Brain tumors can be classified in many ways, for instance, primary and secondary tumors. The primary one deals about 70% of all brain tumors, while secondary tumors are the residuals 30%. This classification is determined according to tumors origin just as tumors first originate in the brain are called primary tumors. On the other side, tumors first arise in any other part of the body and then transferred to the brain are called secondary tumors, and most of them are malignant. Numerous imaging techniques can be used to detect and classify brain tumor.

Gliomas are the most prevalent type of brain tumors that originate in the glial cells of the brain. Gliomas include 30% of all brain tumors and central nervous system (CNS), and 80% of all malignant brain tumors. Gliomas classified into four grades according to the worlds health organization (WHO) starting from type I to IV. Grade I tumors are benign and have a much similar texture of the normal glial cells, Grade II is a slightly different in texture, Grade III tumors are malignant with abnormal tissue appearance while grade IV is the most severe stage of gliomas and tissue abnormalities that can be visualized by naked eye. Meningioma is a tumor that forms on the membrane that covers the brain and spinal cord inside the human skull and grows placidly. Most of meningioma tumors are benign. However, pituitary tumor starts from the pituitary glands that control hormones and regulate functions in the body. It can be benign, benign that expands to bones, and malignant. Complications of pituitary tumors may cause permanent hormone deficiency and vision loss. By cause of the information mentioned above, early detection and classification of brain tumors turn into a vital task in case assessment and accordingly help in selecting the most convenient treatment method to save patients life. Furthermore, the classification stage may be a confusing and tedious task for physicians or radiologists in some complicated cases. These cases need experts to work on, localize the tumor, compare tumor tissues with adjacent regions, and apply filters on the image if necessary; to make it more precise for human vision, and finally conclude; whether it is a tumor besides its type and grade if available. This task relatively consumes time, and that's why there is a need for a Computer Aided Diagnosis (CAD) system to early detect brain tumors in much less time without human intervention.

Macine learning algorithms have been widely emerged in the medical imaging field as a part of artificial intelligence. It can be divided into two main categories, supervised and unsupervised. In supervised techniques, an algorithm is used to find a mapping function of input variables and their related output labels to predict new subjects labels. The state of art approaches deals about learn inherent patterns within the training data using algorithms such as Artificial Neural Network (ANN), Support Vector Machine (SVM), and K-Nearest Neighbors (KNN).In contrast, unsupervised learning is based only on the input variables as in fuzzy c-means and Self-Organization Map (SOM). There is a must to extract features of the training images that are usually grayscale, texture and statistical features to establish learning and perhaps require segmenting tumor in most cases before features extraction stage. These features are called handcrafted features in which an expert who has a strong knowledge and the ability to form the most meaningful features is needed. Moreover, this job consumes much time and is prone to error while handling large scale of data.

II. LITERATURE SURVEY

Bangare et al [1], introduceda DL model based on a convolution neural network is proposed to classify different brain tumor types using two publicly available datasets. Authors proposed method, in which the system starts to load and extract images and labels from datasets raw files and then make a preprocessing and augmentation techniques just after splitting the dataset into training, validation and test sets. Then, the structure of the proposed method is introduced, followed by setting the hyper-parameters, regularization techniques, and optimization algorithm. Finally, network training and performance computations are presented.

Lavanyadevi et.al [2] proposed method takes the similar MRI images. In this work author used four major steps in the proposed approach. The first step is pre-processing; the second step is feature extraction using Gray Level Co-occurrence Matrix (GLCM). The third step is classification using PNN (Probabilistic Neural Network); and last step is segmentation using K-means clustering algorithm.

Hossam et al. [3] proposed the method converts the MRI into Grey Scale image and then to binary image which helps in noise reduction. After that system apply histogram equalisation which helps in increasing intensity of image. Then apply canny edge detection which works as filter to the passed image and then apply morphological operations on image. Genetic algorithm helps for feature selection. After morphological operations proposed method apply support vector machine (SVM) algorithm for tumor detection. Here the mixed method approach shows the possibility of better brain tumor classification. The proposed system will be definitely useful for the precise diagnosis of tumor and tissues in medical field. Future scope is to use Neural Network and Fuzzy systems for the Classification of Tumor and tissues.

Varuna Shree at.al [4] concentrated on noise removal technique, extraction of gray-level co-occurrence matrix (GLCM) features, DWT-based brain tumor region growing segmentation to reduce the complexity and improve the performance. This was followed by morphological filtering which removes the noise that can be formed after segmentation. The probabilistic neural network classifier was used to train and test the performance accuracy in the detection of tumor location in brain MRI images. Authors proposed method describes the materials, the source from which the brain image data collected and the algorithms for brain MRI segmentation and feature extraction. The methodology proposed includes application on brain MRI images of 256 X 256, 512 X 512 pixel size on dataset. It is converted into gray scale for further enhancement.

Khalid Usman et.al [5] investigate wavelet texture features along with various machine learning algorithms. Here used multi-modality images to classify the brain tumor. This work makes the contributions extracting wavelet-based texture features to predict tumor labels and exploring supervised classifiers for brain tumor classification. In this work, the author used MICCAI BraTS data and relies on intensity-related features and wavelet texture features. The algorithm is applied on BraTS challenge training dataset, and it gives better results than the state-o fthe-art methods. R. Anjali at.al[6] proposed system segments and classifies the brain tumor in multiple stages. First stage is segmentation where the brain portion is separately from the skull part and all other portion present in an image. In Pre-processing noise present in the image is removed. After this, features are extracted and among those features, feature selection process involves. Finally classification method classifies the tumorous region.

Deepa et al. [7] presented a mixture model based segmentation and classification of brain MRI for tumor identification. The proposed robust mixture estimator combining trimming of the outliers is based on component wise confidence level ordering of observations. The proposed method consists of three stages. In the first stage, the brain MRI is segmented into white matter (WM), gray matter (GM), Cerebrospinal fluid (CSF), and outliers by ordering of observations. In second stage, outliers consists of tumor cells in which eight type of features Contrast, Correlation, Homogeneity, Energy, Entropy, Standard deviation, Skewness, and Kurtosis are extracted. In the third stage, the extracted features are trained by Artificial Neural Network (ANN)and based on this a brain tumor identification scheme is established to examine those features to judge whether brain tumor is present in the given image or not.

Ismael et al. [8] present a framework for classification of brain tumors in MRI images that combine statistical features and neural network algorithms. This algorithm uses region of interest (ROI), i.e. the tumor segment that is identified either manually by the technician/radiologist or by using any of the ROI segmentation techniques. We focus on feature selection by using a combination of the 2D Discrete Wavelet Transform (DWT) and 2D Gabor filter techniques. We create the features set using a complete set of the transform domain statistical features. For classification, back propagation neural network classifier has been selected to test the features selection impact. To do so, we used a large dataset consisting of 3,064 slices of T1-weighted MRI images with three types of brain tumors, Meningioma, Glioma, and Pituitary tumor. Ahmed karat et.al [9] discussed an efficient detection of brain tumor from cerebral MRI images. The methodology consists of three steps: enhancement, segmentation and classification. To improve the quality of images and limit the risk of distinct regions fusion in the segmentation phase an enhancement process is applied. We adopt mathematical morphology to increase the contrast in MRI images. Then we apply Wavelet Transform in the segmentation process to decompose MRI images. At last, the k-means algorithm is implemented to extract the suspicious regions or tumors. Some of experimental results on brain images show the feasibility and the performance of the proposed approach.

Praveen G B et.al[10] discussed a multi stage approach has been proposed to detect tumor, classify them into glioma or meningioma and perform their segmentation. In the first stage, pre-processing is performed, which includes noise filtering, image cropping, scaling operations and histogram equalisation. Feature extraction is performed in the second phase in which 19 features were extracted from grey level co-occurrence matrix, grey level run length matrix and histogram based techniques which are the input to the classifier. Random forest classifier has been used to magnetic resonance images into normal or abnormal and if abnormal, into glioma or meningioma. Final phase deals with tumor detection performed using fast bounding box and the tumor segmentation using active contour model. Antony et. al. [11] concluded that MR imaging is a well established imaging technique to identify and diagnose brain tumor at a very early stage. The tumor types are segregated as glioma, meningioma, metastatis, sarcoma etc. Tumor grades can be segregated into four grades depending on the level of severity. This paper present recognition of brain tumor type as glioma and meningioma grade using Weighted Neighbour Distance using Compound Hierarchy of Algorithms Representing Morphology(Wndchrm) and support vector machines (SVM) classifier Initially, features are extracted using Wndchrm tool and the most informative features are selected based on Fischer score. The SVM classifier is optimized using an iterative method in order to obtain the best constraint and kernel parameters. The optimized features obtained from Wndchrm tool is used to train SVM.

Arun Kumar et al. [12] presented hybrid model of PSOSVM for brain tumor classification. Instead of taking all the features we select minimum required features with the help of bio-inspired algorithms named PSO.Less numbers of feature but all which are important, leads to increase the classification accuracy are taken by PSO. Taking important features only increase the efficiency and decrease the computation time. By using PSO-SVM classification model we get the 95.23 % in compare to 86.82% accuracy of simple SVM classifier if all the 14 features have been included. Similarly Specificity is 94.8 % and Sensitivity is 100 %.

III. METHODOLOGY

Figure 4.1 shows the block diagram of the method used by many researchers as a primary work, in which the system starts to load and extract images and labels from datasets raw files and then make a preprocessing and augmentation techniques just after splitting the data set into training, validation and test sets. Then, the structure of the proposed method is introduced, followed by setting the hyper-parameters, regularization techniques, and optimization algorithm. Finally, network training and performance computations are presented.

Brain tumors can be different in shape, location, and size according to their types and grades as figured in Figure 4.2.The dataset includes three different views: axial, coronal and sagittal views as shown in Fifure 4.3. The second dataset is obtained from The Cancer Imaging Archive (TCIA) public access repository. The Repository of Molecular Brain Neoplasia Data (REMBRANDT) contains MRI multi-sequence images from 130 patients with different diseases, grades, races, and ages. We selected images on T1-weighted contrast-enhanced that include different grades of glioma (Grade II, Grade III, and Grade IV) as shown in Figure 4.4.

Additionally, two dropout layers are used to prevent over fitting followed by a fully connected layer and a softmax layer to predict the output and finally a classification layer that produces the predicted class. Although the dataset is relatively not big (due to the variety of imaging views), data augmentation helped well to show better results and hence overcome this problem. Our proposed architecture is to achieve the high accuracy concerning the datasets used.

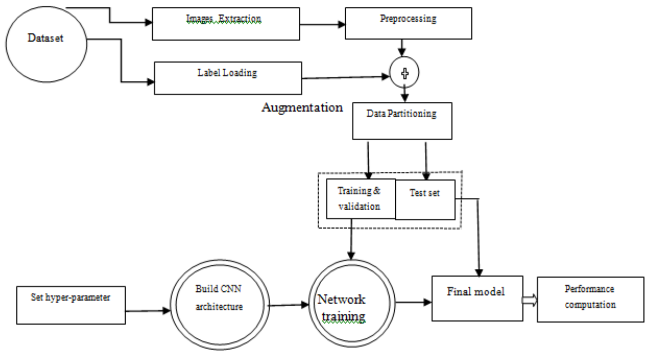

Figure 4.1 Block diagram of typical system

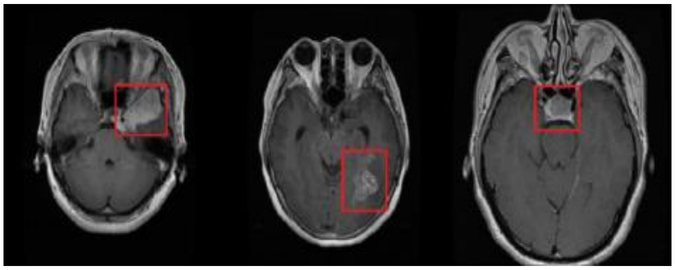

Figure4.2 Different three axial brain tumor types as follows, Meningioma, Glioma and Pituitary tumor from left to right respectively

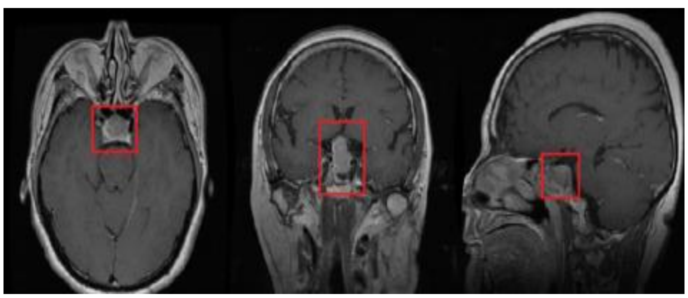

Figure 4.3 Pituitary tumor is demonstrated in three different acquisition views(Axial, Coronal, and Sagittal) from left to right respectively. Tumors are localized inside a red rectangle.

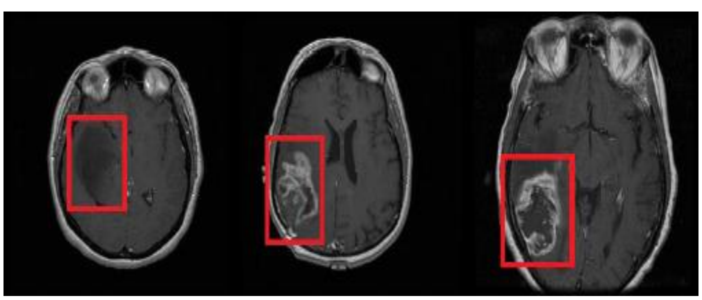

Figure4.4 Different glioma grades included in REMBRANDT dataset (Grade II,Grade III and Grade IV from left to right respectively). Tumors are localized inside a red rectangle.

IV. CONCLUSION

Different researchers worked on various method s of brain tumor classifications. Brain tumour is one of the deadly disease and according to the world cancer report published by the World Health Organization (WHO), brain cancer accounts for less than 2% of human cancer. CAD system for the classification of brain tumor MR images into three types(meningioma, glioma, and pituitary) in one study, and further classifying of gliomas into different grades (Grade II,Grade III and Grade IV) using a custom deep neural network structure. Most of the researchers proposed network construction from 16 layers starting from the input layer which holds the preprocessed images passing through the convolution layers and their activation functions. Additionally, two dropout layers are used to prevent over fitting followed by a fully connected layer and a softmax layer to predict the output and finally a classification layer that produces the predicted class. Although the dataset is relatively not big (due to the variety of imaging views), data augmentation helped well to show better results and hence overcome this problem. This work concludes state of art approaches states that various detections procedures and classification methods.

REFERENCES

[1] Sunil L. Bangare, G. Pradeepini, Shrishailappa T. Patil, “Brain Tumor classification using mixed method approach”,in International Conference by IEEE, ISBN: 978-1-5090-6357-8, Feb 2017,DOI:10.1109/ICICES.2017.8070748.

[2] R. Lavanyadevi,M. Machakowsalya,J. Nivethitha,A. Niranjil Kumar, “Brain Tumor classification and segmentation in MRI images using PNN”, in International Conference by IEEE, ISBN:978-1-5090-4996-7, April2017, DOI:10.1109/ICEICE.2017.8191888

[3] Hossam H. Sultan , Nancy M. Salem ,Walid Al-Atbany, “Multi classification of brain tumor using deep neural network ”,in International Conference by IEEE, ISBN: 2169-3639,May 2019,DOI:10.1109/ACCESS.2019.2919122

[4] Varuna Shree,T.N.R. Kumar,” Identification and classification of brain tumor MRI images with feature extraction using DWT and probabilistic neural network” , in International Journal by Springer, December 2017, Volume:5, Issuse:1, ISBN:2198-4018, DOI:10.1007/s40708-017-0075-5.

[5] Khalid Usman, Kashif Rajpoot,” Brain tumor classification from multi-modality MRI using wavelets and machine learning”, in International Journal by Springer, January 2017, DOI:10.1007/s10044-017-0597-8.

[6] R.Anjali, S.Priya,"An Efficient Classifier for Brain Tumor Classification", in International Journal by Springer, August 2017, Volume:6, Issuse:8, ISBN:2320-088X.

[7] Ayal Raj Deepa, Wilson Rizy Mercy Sam Emmanuel," Identification and classification of brain tumor through mixture model based on magnetic resonance imaging segmentation and artificial neural network", in International Journal by Wiley, March 2017, DOI:10.1002/cmr.a.21390.

[8] Mustafa R. Ismael, Ikhlas, Abdel-Qader,**"**Brain Tumor Classification via Statistical Features and Back-Propagation Neural Network ",in International Conference by IEEE, 2018,DOI:10.1007/s40708-017-0075-5.

[9] Ahmed Kharrat , Nacera Benamrane , Mohamed Ben Mesaaoud, "Detection of Brain Tumor in Medical Images" ,in International Conference by IEEE, ISBN:978-1-4244-4397-0, February 2010,DOI:10.1109/ICSCS.2009.5412577.

[10] Praveen G.B, Anita Agrawal, **"**Multi stage classification and segmentation of brain tumor", in International Conference by IEEE, March 2016, ISSN:978-9-3805-4421-2

[11] Anita Antony, Ahammed Muneer K V,**"** Feature Optimization and Classification of Tumor Grades using MR Images", in International Conference by IEEE, 2018, DOI:10.1109/CETIC4.2018.8530951.

[12] Arun Kumar, Alaknanda Ashok,M.A.Ansari **,"**Brain Tumor Classification Using Hybrid Model Of PSO And SVM Classifier **",**in International Conference by IEEE, 2018, DOI:**:** 10.1109/ICACCCN.2018.8748787.