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A Review on the Brain Tumor Detection and Segmentation Techniques

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Abstract - *Medical image processing is one of the prime applications of image processing. Brain tumor detection is one of the completed tasks in the medical image processing. Various researchers are working on the tumor detection from the medical images in its earlies stage so that patient can be given treatment before the tumor become cancer. Magnetic resonance imaging is used to capture the tumor images of the brain. Various segmentation techniques are used to extract the tumor exact periphery and shape. In this paper a review on various brain tumor detection and segmentation techniques is performed and various remarks are stated.*

Key Words: Brain tumor, segmentation, medical image processing, edge detection, datasets, accuracy

1.INTRODUCTION

The human body has lot of cells and if proper growth of these cells is not regular then extra cell can create a mass of tissue which is called tumor. With the time this tumor can produce risk of life of patient. Some tumors are cancer free but others are very dangerous for the human body. Various researchers are performing various studies so that tumor can be detected as earliest as possible. Below a comprehensive survey of brain tumor is performed which provides deep insights of the research performed.

1.1 LITERATURE SURVEY

Y. D. Zhang et al. [1] in 2012 proposed a method for grouping a magnetic resonance scanned brain digital image into the category of normal or abnormal tumor images. Proposed algorithm utilized wavelet transform for fetching various features from digital images, and then utilizing principal component analysis (PCA) to lower the size of various attributes and was used in kernel support vector machine. The theory of K-fold cross validation algorithm was utilized to increase generalization of KSVM. Authors had chosen 7 normal brain ailments as abnormal brains, and had gathered total number of 160 MR brain images and out of which twenty are normal and one forty are abnormal. Author showed that the GRB kernel achieved the maximum classification accuracy equivalent to 99.38 percent in comparison to other kernels like LIN, HPOL, and IPOL. Investigation data showed that proposed technique performed well.

A. Aslam et al. [2] in 2015 proposed an improved edge detection algorithm for brain-tumor segmentation which was relied on the well-known Sobel edge detection. Author created a hybrid model with Sobel and thresholding method. With the help of it author found various regions utilizing closed contour algorithm. In the end tumors were segmented and extracted from the sample image utilizing intensity values within the contours. Author used C programming language for creating the algorithm. Author used gray level Uniformity measure, Q-measure and Relative Ultimate Measurement Accuracy for performance evaluation. From the results author showed that the proposed algorithm provides better performance over traditional segmentation methods.

N. Nabizadeh et al. [3] in 2015 proposed automated algorithm for brain tumor detection and extraction. Author used MRI intensity normalization, windowing, feature extraction, dimensionality reduction, classification, post-processing and feature efficacy evaluation for tumor detection and segmentation. The supposed technique was relied on histogram asymmetry amid the two brain hemispheres for tumor slice detection. Author used sensitivity, specificity, and accuracy for performance evaluation. Outcomes of the algorithms showed that the proposed technique was able to successfully segmented brain tumor tissues with good accuracy and low computational complexity. Author performed a deep study which evaluated the efficacy of statistical features with the help of Gabor wavelet features with many classifiers.

P. Shanthakumar et al. [4] in 2015 detected the brain tumor with the help of various new approaches. Author used enhancement stage, anisotropic filtering, feature extraction, and classification for detecting and extracting tumor. Author employed histogram equalization in the image enhancement stage. Further gray level co-occurrence matrix as well as wavelets was utilized as features. In the last step support vector machine classifier was used for training of extracted features. Author used well known Watershed segmentation for tumor segmentation. Author used the gradient map of the tumor image as a relief map which helped in segmented the test brain MRI image as a dam. Author detected the tumor region with the help of morphological operations. Performance of the proposed was measure with the help of sensitivity, specificity, accuracy, positive predictive value (PPV), and negative predictive value (NPV). The proposed system achieved 95 percent of sensitivity rate, 96 percent of specificity rate, 94 percent of accuracy rate respectively.

E. Dandil et al. [5] in 2015 proposed a computer aided design system for detecting brain tumors with the help of T1 and T2 weighted magnetic resonance digital images. The designed system segmented brain tumor region of images with the help of Fuzzy C-Means method. Author used the support vector machine method for classification of different types of tumors in the CAD system. The proposed system was

simulated in MATLAB software. Experimental studies were conducted with the computer with i7 processor, 8 GB RAM and Windows 7 operating system. There was total 376 digital images in the dataset. Out of which 188 images of the data were used for training purposes while 188 images were utilized for testing purposes. Authors created a confusion matrix for verifying the tumor classification performance. The proposed method recognized brain tumors with 91 percent accuracy, 90 percent sensitivity and 94 percent specificity.

S. R. Telrandhe [6] in 2016 proposed brain tumor detection method using medical image processing. Authors had utilized well known K-Means image segmentation process for tumor segmentation. Algorithm first denoised the images with the help of median filtering. Further authors had used labeled various objects present in the image. Author utilized support cector machine for making adaptable system. SVM was utilized in an unsupervised way that would be used to design as well as regulate the pattern for further utilization. Authors had to search for the features present in the patterns to train SVM. Further image was partitioned with the use of K-Means segmentation as well as labeling of objects with the use of histogram of gradients (HOG). Main aim after the use of many colors in segmentation was to recognize a region of interest out of the MRI digital images because human eyes are very sensitive for color in comparison to grey scale images. Authors were able to get good results with the proposed algorithm.

A. Goel et al. [7] in 2016 had proposed a robust method for classifying gender based on the digital images. Author used discrete wavelet transform for creating the featured array. Discrete Cosine transformation provided the final digital image. Benefit of hybrid method was that both transforms had lowered the dimension of feature vectors size quite gently. Further author used the feature vectored as input to the support vector machine to classify the digital images. Author used three databases of faces AT@T, Faces94 and Georgia Tech were utilized to search the proficiency of above method for gender grouping into different categories. Out of three databases AT@T got 97.375% that was displayed with first level DWT and which then further processed by DCT. Faces94 database produced total accuracy of 99.7% with the same scheme generated by above database. Good outcomes on Georgia Tech database was found with accuracy of 99.13 percent which again displayed by pre first order DWT and post processing by DCT.

D. Somwanshi et al. [8] in 2016 had examined and evaluated different threshold as well as entropy relied image segmentation techniques on the concept of simulation outcomes. Different entropy techniques namely shannon, Renvi, Vajda, Havrda-Charvat and Kapur had executed on the available MRI images of brain tumor as well as the inner part of body and results of these were analyzed and compared. It was found that optimum threshold selection of digital images was relied on given entropy techniques were very good in diagnosis of tumor in human body. On comparing and analyzing the simulation outcomes, authors found that havrda-charvat entropy showed good results in comparison to other entropy algorithms in terms of color balancing and received an accurate picture. On the second place the Renyi Entropy was found to be good while detecting the brain tumor at stage second. Remaining other entropies segmented and detected the tumors at its last stage that was when the tumor became malignant.

S. Pereira et al. [9] in 2017 proposed a convolutional neural network approach for automatic tumor image segmentation. Authors proposed algorithm was presented and analysed in the Brain Tumor Segmentation Challenge 2013 database. This algorithm was awarded the overall first position for the fully, deep, and improving parts having cost of Dice Similarity Coefficient metric was 0.88, 0.83, 0.77 for the given data set. Further it received the first rank in the online execution platform. In 2015 authors also performed in the BRATS competition in 2015. With utilizing the same prototype authors obtained the second position, with DSC metric of 0.78, 0.65, and 0.75 for all the above-mentioned regions respectively. In comparison to the best generative prototype, authors reduced the overall execution time to nearly by ten-fold.

V. Shreyas et al. [10] in 2017 proposed convolution neural network algorithm for brain tumor detection and extraction. Author used the BraTS database for the training and testing of the proposed algorithm. Author was able to get the dice scores of 83 percent in the complete tumor region and 75 percent in the deep region and 72 percent in the enhancing part. Proposed model segmented the complete test set which had seventy four three dimensional images in about 16 minutes and while the other model had taken more than 3 hours on Quadro K4000 GPU under the equivalent execution environment. In medical imaging applications, where a large amount of data has to be processed the time executed a task is the main bottleneck. So in that perspective, the authors above supposed model proved to be very courageous.

S. K. Shil et al. [11] in 2017 proposed scheme comprised of Otsu binarization followed by K means clustering for segmentation. To fetch features as well as reduce the dimensions of attributes after Discrete Wavelet Transform (DWT) algorithm Principal Component Analysis (PCA) was respectively used. These features were fed to a Support Vector Machine (SVM) for classification purposes. Initially, brain MRI was loaded by the system, then preprocessing, processing, post processing and classification was executed. In the preprocessing stage, gray conversion and otsu binarization was applied upon the image. In the processing stage, K-means and segmentation was employed. The scheme had been evaluated for its detection and classification accuracies after running the process for a large sum of data (i.e. the large number of MRI images). Experiments showed that the proposed scheme achieved a classification Accuracy of 99.33%, Sensitivity 99.17%, and Specificity 100%.

C. H. Rao et al. [12] in 2017 presented an automatic technique to search and partition the tumor present in different brain regions. The supposed technique consisted of 3 prime steps which were segmentation, prototyping and optimizing the given energy functions. Making proposed technique more efficient authors used the data inside the T1

as well as the FLAIR MRI digital images. Conditional random field was utilized to build above framework to group the knowledge present in T1 as well as in FLAIR in probabilistic domain. Prime advantage of this framework was that one could prototype complex shapes very efficiently and fed the generated values in energy function. Authors found 92.3 percent sensitivity and 96 percent specivity at the detection phase. For strong quantitative result of segmentation performed dice coefficient is utilized as an objective parameter. Algorithm showed mean accuracy of nearly 89 percent but maximum is 98% as compared with 79% and maximum is 86 percent of MRF relied image segmentation technique. With the use of T1-weighted information proposed algorithm move better with an average of 10% improvement on segmentation performance.

T. M. Devi et al. [13] in 2018 grouped magnetic resonance brain digital input images into either normal as well as abnormal with the help of a proposed method of tumor detection. Authors used a DWT algorithm which helped in getting image attributes from the initial image. For decreasing the size of the featured image principal component analysis was performed. After this phase feature digital image was inputted to KSVM for further processing. The original data set had ninety brain MR digital images which have both normal and abnormal collection and had 7 same diseases. Each discrete wavelet transforms as well as Fejer Korovkin discrete filters which were utilized by authors gave sound outcomes which have good classification accuracy. Tumor is segmented by using the concept of thresholding. Authors used the Gaussian Radial Basis kernel to classify and as a result of which it generated accuracy of 98% in comparison to linear kernel.

G. Raut et al. [14] in 2020 utilized well known deep learning technique which was based on neural networks to detect and as well as segment of brain tumor in the magnetic resonance images. Author had used convolutional neural network model to predict brain tumor in the sample digital images. Author pre trained the deep learning model on the available dataset for predicting images both as normal and as well as with tumor. In the middle of the algorithm author had used the autoencoders which removed noise from the images. For image segmentation author had used K-means method. Author had used the available Kaggle dataset with 250 images. From the experiments author got 95 percent accuracy with the help of proposed technique.

A. S. Methil et al. [15] in 2021 supposed a new brain tumor detection technique and this technique was primarily based on the deep learning neural network architecture and also on the digital image processing techniques. In the initial stage some initial preprocessing algorithms of digital image processing were applied which include histogram equalization and opening and closing operations. In the second step author created a convolutional neural network model which was used for training purposes. Author had used different digital images which were varied in the shape, size, texture and in the location of tumor. Author had used a dataset which had more than had 4000 images which includes both tumor and non-tumor digital images. From the results author got nearly 99 percent accuracy in the training stage and received near by 100 percent accuracy in testing stage.

3. CONCLUSION

In this review paper brain tumor detection and segmentation techniques are discussed. Various research papers from 2012 to 2021 are discussed and their findings are written. Brain tumor detection is one of the most dominant areas of medical image processing and it has lot of scope of research in the future.

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