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A Comparative study on Magnetic Resonance Image Processing for Brain Tumor Classification

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Abstract:*The abnormal growth of brain cells inside the brain is termed as a brain tumor.Detection of brain tumor is a very challenging task since there is similarity between the tumor cells and the normal tissues in the brain. In medical science Magnetic Resonance Imaging (MRI) can provide detailed analysis of the soft tissue anatomy that is very much helpful in the diagnosis of tumor cells. Several stages are involved in detecting the brain tumor tissues, namely: image preprocessing, segmentation, feature extraction and classification. In this paper, we have provided a review of image processing techniques in the context of brain MRI processing and critically analyzed them for the identification of the gaps so that the gaps can be filled for precise and better results.*

Keywords*: Image preprocessing MRI, segmentation, feature extraction, classification.*

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I. Introduction

The present era has tremendously increased with the research and development of various techniques which are helpful in making the technological advancements in the medical field by easing the diagnostic processes with increased accuracy.

The tumor is mainly characterized by growth of abnormal cells beyond their usual boundaries that can then invade adjoining parts of the body & spread to other organs. It is the 2nd leading cause of death globally with 8.8 million cancer related deaths worldwide in 2015, annual no. of new cases are projected to rise from 14.1 million in 2012 to 21.6 million in 2030. Brain tumors can have various sizes and shapes and may appear at different locations. It can be cancerous (malignant) or noncancerous (benign) [2]. When benign or malignant tumors grow, they can cause the pressure inside the skull to increase. This can cause brain damage, and it can be life-threatening. Brain tumors are categorized as primary or secondary [1]. A primary brain tumor originates in the brain and many primary brain tumors are benign. Benign tumors don'tspread from one part of our body to another. Some suspected causes of benign tumors include a traumatic injury at the tumor location, chronic inflammation, an undetected infection or diet. In adults, the most common types of brain tumors are gliomas and meningiomas [4]. A secondary brain tumor, also known as a metastatic brain tumor, occurs when cancer cells spread to brain from another organ, such as lung or breast. Secondary brain tumors are always malignant.

Computer and Information Technology are very much useful in medical image processing, medical analysis and classification. The numerous types of medical imaging technologies based on non-invasive approach like; Ultrasound, MRI(Magnetic resonance imaging), SPECT(Single-photon emission computed tomography), CT (Commuted Tomography)scans, PET (Positron Emission Tomography)and X-ray are used. C.T. And PET is not generally used for creating images of brain cancer as it is used for other types of cancer. MRI is mainly used to diagnose brain tumors. It can be used to produce images of any part of the body and it provides an efficient and fast way for diagnosis of the brain tumor. More often medical images are usually obtained by X-rays and MRI. The MRI image may contain both normal and abnormal images. MRI is an essential tool in the clinical and surgical environment due to superior soft tissue differentiation, high spatial resolution, contrast and it does not use any harmful ionizing radiation which may affect patients [7] [13]. It is also an important diagnostic imaging technique for the early detection of brain tumor. MRI brain image plays an imperative role in assisting radiologists to access patients for diagnosis and treatment [1].

Computer aided diagnosis for automatic detection of brain tumors through MRI can provide highly accurate reconstruction of original images of the tumor. The researchers require a thorough study of medical image processing which includes pre-processing, segmentation, feature extraction, feature selection and classification as shown in Fig 1.

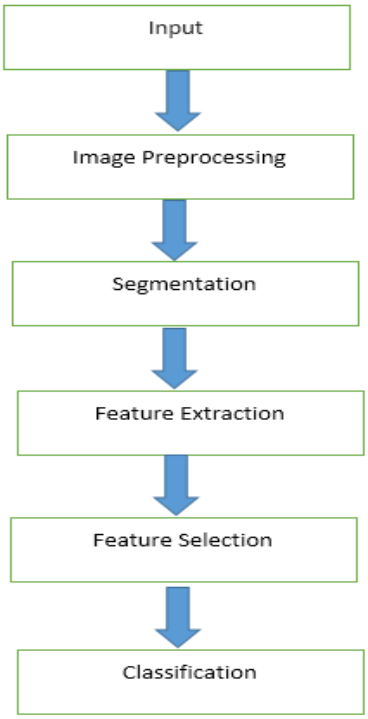

Fig1: Steps involved in the automatic detection of brain tumors through MRI processing.

The first step, i.e.pre-preprocessing improves the standard of the brain tumor images and makes these images suited for future processing by clinical experts or imaging modalities. It also helps in improving the parameters of MR images. The parameters include improvement in signal-to-noise ratio, enhancement in visual appearance of MR images, the removal of irrelevant noise and background of undesired parts, smoothing regions of the inner part, maintaining relevant edges.

The segmentation is a process where the image is partitioned into different regions. Let an entire region of the image be represented by S. Segmentation process can be viewed as partition of S into p subregions like S_1, S_2, S_3, …S_p. Certain conditions have to satisfy, such as the segmentation must be intact; that is each and every pixel should be within the region, every point in the regions should be connected in some sense, regions should be disjoint, etc [2].

Feature extraction is the process of extracting quantitative information from an image such as color features, texture, shape and contrast.

Finally in the classification step, the features are classified to detect the type of Brain Tumor i.e. benign, malignant or normal.

The main objective of this paper is to review the previous studies related to MR image processing for brain tumor image classification.

II. Review ofLiterature

Jothi G *etal.*[33], have proposed a hybrid supervised feature selection algorithm, called TRSFFQR (Tolerance Rough Set Firefly based Quick reduct) and applied for MRI brain images.Different categories of features were extracted from the segmented MRI images, i.e. shape, intensity & texture based features. The author used hybridization of two techniques, Tolerance Rough Set (TRS) & Firefly Algorithm (FA) to select the imperative features of brain tumor. The performance of the proposed algorithm was compared with Artificial Bee Colony (ABC), Cuckoo Search Algorithm (CSA), Supervised Tolerance Rough Set n- PSO based Relative Reduct (STRSPSO-RR) & Supervised Tolerance Rough Set n- PSO based Quick Reduct (STRSPSO-QR). The results were further compared & it was observed that the proposed technique was effective & improved by reference to the existing supervised feature selection algorithms.

Kalyani*etal.*[4], presented an updated survey of current methods for constructing decision trees and classifying brain tumors. The paper mainly focused on classification and solving the cancer problem using single decision tree classifiers such as CART & Random decision algorithm. The results of the researchwere

comparedwith the existing classifiers by the researcher and found the accuracy of 98.5%.The author proposed that the system is expected to provide valuable diagnostic techniques for the physicians.

NileshBhaskarrao*etal.*[9], proposed the technique of evaluating & validating the performance & quality analysis on MRI images using biologically inspired BWT & SVM classifiers based on accuracy, sensitivity & specificity & dice similarity index coefficient. The results achieved 96.5% accuracy, 94.2% specificity & 97.72% sensitivity.

Aparna *etal.*[10], has used data mining methods for classification of MRI images using modified hybrid technique based on FCM & SVM classifiers. The first stage of the algorithm applied was noise reduction using median filtering. (FCM) fuzzy C-means were used by the authors for segmentation of the image to detect the suspicious region in brain MRI image & features such as GLCM(gray level co-occurrence matrix) is used for extraction of feature from the brain image they have applied the SVM technique to classify the brain MRI images. The authors have proved that the hybrid methodology combining FCM & SVM for classification gives accurate result for identifying the brain tumor.

Neha Rani *etal.*[16] used Feed forward backdrop neural system to classify the images. The statistical analysis morphological and thresholding techniques were used to process the images obtained by MRI. Results showed that the methodused hasthe highest accuracy and less iterations were detected.

Bjoern H. Menze *et al.*[17], reported the set-up and outcomes of the Multimodal Brain Tumor Image Segmentation Benchmark sorted out in conjunction. Twenty best in class tumor segmentation algorithms were connected to an arrangement of 65 multi-differentiate MR filters of low-and high-review glioma patients – physically commented on by up to four raters and to 65 practically identical outputs produced utilizing tumor picture simulation programming. Quantitative evaluation revealed considerable disagreement between the human raters in segmenting various tumor sub-regions (Dice scores in the range 74-85%), illustrated the difficulty of that task. They found that different algorithms worked best for various sub-areas, yet that no single algorithm positioned in the best for all sub-regions at the same time.

Taranjit Kaur *et al.* [18], proposed a novel feature selection technique for the MR brain tumor picture order that aims to pick the optimal feature subset with maximum discriminatory ability in the base sum of time. It depends on the combination of the Fisher and the parameter Free Bat (P-Free Bat) advancement algorithm. As the ordinary Bat calculation was terrible at investigation, a change was suggested that aides the Bat by the pulse frequency, worldwide best and the neighborhood best position.

Jayachandran *et.al.*[19], proposed a hybrid algorithm for recognition of brain tumor in Magnetic Resonance pictures utilizing measurable highlights and Fuzzy Support Vector Machine (FSVM) classifier. On the main stage anisotropic channel was connected for noise reduction and to make the picture reasonable for extracting features. In the second stage, got the surface highlights identified by MRI pictures. In the third stage, the highlights of magnetic resonance images have decreased utilizing standards segment investigation to the most fundamental highlights. At the last stage, the Supervisor classifier based FSVM has beenutilized to group subjects as typical and anomalous mind MR pictures.

Mohammad Majid al-Rifaie *et al.*[20], proposed an umbrella deployment of swarm intelligence algorithms. The particle swarm optimization was utilized to prepare the LVQ which eliminated the emphasis subordinate nature of LVQ. The proposed technique was utilized to recognize the tumor areas in the abnormal MR brain images.

Anitha *et al.*[21] utilized the adaptive pillar K-mean algorithm for effective division and also the order technique was finished by the two-level characterization approach. In the proposed framework, at first the self-sorting out guide neural system prepared the highlights extricated from the discrete wavelet change mix wavelets furthermore, the resultant channel factors were thus prepared by the K-closest neighbor and the testing procedure was moreover fulfilled in two phases. The proposed two-level order framework orders the brain tumors in twofold preparing process which gives best execution over the customary arrangement technique. The proposed system had been approved with the help of genuine informational sets and the experimental outcomes indicated improved execution. Early and exact discovery of tumors, enhanced the personal satisfaction of ontological patients.

Athency Antony *et al*. [22] proposed a compelling strategy for brain tumor location and order. Essentially, the brain tumor was an abnormal development caused by cells replicating themselves in an uncontrolled way. Brain tumors were having expansive inconstancy in their attributes compared with other tumor tissue. So that for viable characterization the deep learning method convolutional neural system (CNN) was utilized. The technique pre-forms MRI images classifies and concentrates tumors utilizing MATLAB.

El-Sayed *etal.* [23] proposed a technique that is based on the following computational methods: the feedback pulse-coupled neural network for image segmentation, the discrete wavelet transform for feature extraction, the principal component analysis for reducing the dimensionality of the wavelet coefficients, and the feed forward back-propagation neural network to classify inputs into normal or abnormal. The experiments were carried out on 101 images consisting of 14 normal and 87 abnormal (malignant and benign tumors) from a real

human brain MRI data set. The classification accuracy of both training and test images found were 99%.Moreover, the proposed technique has demonstrated its effectiveness as compared with the other machine learning techniques. The results have revealed that the proposed hybrid approach is accurate, fast and robust.

V.P. Gladis*etal.*[25] proposed a method for feature selection & extraction. The experiment had been performed on 140 tumors contained brain MR images.PCA and Linear Discriminant Analysis (LDA) were applied on the training sets. The Support Vector Machine (SVM) classifier was used as a comparison of nonlinear techniques Vs linear ones. The author said that the feature selection using the proposed techniques ismore beneficial as it analyses the data according to grouping class variable and gives reduced feature set with high classification accuracy.

Su Ruan *etal.*[26] presented fuzzy Markovian method for brain tissue segmentation from magnetic resonance images. The method used is an unsupervised one & therefore it first estimates the parameters of the fuzzy Markov random field model using a stochastic gradient algorithm & then the fuzzy Markovian segmentation were performed automatically. The proposed segmentation method has been compared with the most widely used fuzzy C-means algorithm &it was found that the researched method is more robust than Fuzzy C-means algorithm.

Yudong Zhang *etal.* [27] proposed a hybrid technique for MRI brain image classification. The author proposed a neural network (NN) based method to classify a given MR brain image as normal or abnormal. The method first employed wavelet transform to extract features from images, and then applied the technique of principle component analysis to reduce the dimensions of features. The author has sent the reduced features to a back propagation (BP) NN, that scales & further conjugate gradient (SCG) was adopted to find the optimal weights of the NN. The author has applied the method on 66 images (18 normal, 48 abnormal) and found the classification accuracy on both training and test images to be 100%, and the computation time per image was only 0.0451 s.

G. Jothi and H. Inbarani[29] proposed the approach based on the tolerance rough set model that can deal with real-valued data whilst simultaneously retaining dataset semantics. A novel supervised feature selection in mammogram images, using the Tolerance Rough Set - PSO based Quick Reduct (STRSPSO-QR) and Tolerance Rough Set - PSO based Relative Reduct (STRSPSO-RR), was proposed by the authors. The results obtained by these methods had shown increases in the diagnostic accuracy.

III. Conclusion

There is enough amount of published literature available to replace the manual inspection process of MRI images with the digital computer system using image processing techniques. The technological advancements in the field of image processing have resultedin the accurate and speedy detection of tumor in the brain along with identification of the precise location of the tumor.In the future work, different classifiers can be used to increase the accuracy, combining more efficient segmentation and feature extraction techniques with real- and clinical-based cases by using a large dataset covering different scenarios.

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