# INVESTIGATING IMAGE PROCESSING TECHNIQUES ON MRI

**Mandeep**
Research Scholar
Department Of Electronic & Communication Engg.
Galaxy Global Group of Institutions, Dinarpur

**Vikas Chawla**
Faculty, Department of Electronic & Communication Engg.
Galaxy Global Group of Institutions, Dinarpur
Email: chawla.vikas1@gmail.com

**Saranjeet Singh**
Faculty, Department of Electronic & Communication Engg.
Galaxy Global Group of Institutions, Dinarpur
Email: chawla.vikas1@gmail.com

**Abstract**
Image processing plays an important role in analyzing the medical images. Brain tumor detection and segmentation is the most challenging and time consuming task in medical image processing. Magnetic Resonance Imaging (MRI) is an advanced medical imaging technique to analyze internal structure of the body. MRI produces high quality images of human soft tissues which help in diagnosis of brain tumor. Due to complex nature of brain MR images, the accurate segmentation of MR image is important for diagnosis of brain tumor by Computer Aided Detection (CAD) system. After segmentation, the classification of tumor into malignant and benign is a difficult task due to variation in tumor tissue characteristics like gray level intensities, shape, and size. This paper focuses on highlighting the strengths and limitations of the earlier proposed classification techniques. The paper provides an insight into the reviewed literature to reveal new aspects of research.
**Keywords - Magnetic Resonance Imaging(MRI), Brain tumor detection, Image processing, Segmentation.**

## 1.0 Introduction

A brain tumor is an abnormaland uncontrolled propagation of cells. The grading of tumors is done according to how destructive they are. The lower-grade tumors are often benign and higher grade tumors often malignant. Brain tumors on the basis of their origin are classified into primary and secondary. The primary brain tumors stem in the brain whereas secondary tumors spread to the brain from cancer born somewhere else in the body. Lower grade tumors (grade 1 or 2) are generally slow growing masses that are unlikely to spread. These tumors are categorized as benign because they usually stay confined to the site of origin and do not proliferate to the rest of the body. On the other hand, malignant brain tumors have the ability to spread to other tissues.

Malignant tumors are generally secondary tumors that are formed as a result of cancer spread. Primary malignant tumors belong to high-grade (grade 3 or 4), aggressive cancers that grow quickly. These tumors require urgent treatment to block their intrusion to other brain regions or the spinal cord [1]. Early and accurate detection of tumor is essential for efficient treatment planning.

Medical imaging techniques play an important role in detection of tumor. There are various imaging modalities which includes Magnetic Resonance Imaging (MRI), Ultrasound imaging, Computed Tomography (CT), Positron Emission Tomography (PET), X-ray Radiography. Among all the modalities MRI is considered the most efficient tool to analyze the internal structure of the body.The main aim of image processing application is to abstract important attributes from the image data, from which a descriptive, interpretative, or reasonable prospect can be obtained by the machine.

There are several image processing techniques such as histogram equalization, image segmentation, image enhancement, image restoration, image compression, morphological operation, feature selection and extraction and classification.

## 2.0  Literature Review

*A. Kharrat et al.*[2]In their paper presented a method for automated diagnosis, based on classification of human brain MR images. The proposed approach consists of five stages: In the first stage, 2D Discrete Wavelet Transform and Spatial Gray Level Dependence Matrix (DWT-SGLDM) is used for feature extraction. In the second stage, for feature selection Simulated Annealing (SA) is applied to reduce features size. The next stage uses Stratified K-fold Cross Validation to avoid over fitting. In the fourth stage to optimize SVM parameters, GA-SVM model is used. Finally SVM is used to construct the classifier. The method obtained 95.6522% classification accuracy on the T2-weighted brain MRI image datasets. This system could further be used for image classification with difference in pathological conditions, types and disease status. *Ramya* and *Sasirekha*[3] in their paper proposed a segmentation algorithm to detect tumor in 2D brain MR images. The proposed systemconstitutes of three phases: image denoising, skull removal and segmentation. Noise removal is done by using fourth order partial differential equation. Skull removal is done by using two main morphological operators, erosion and dilation. Region growing segmentation is achieved by means of seed point selection.

The accuracy of this method is high compared to watershed segmentation algorithm. Its future work includes classification of tumor stages by using Support Vector Machine(SVM) classifier or Neural Network classifier and tumor size calculation for better analysis of tumor. *S. E. El-Khamy et al.*[4]In their paper presented a combination of Fuzzy C-Mean (FCM) and conformed threshold. The proposed system consists of five stages: the first stage is preprocessing which enhances the intensity of input MR brain image for next stages. The second stage is calculation of the number of clusters for FCM input by applying a rectangular window for image histogram. The third stage is finding the clusters center using FCM. The fourth stage is the brain tumor segmentation using conformed threshold value. The final stage is tumor detection from the segmented image. This method shows better correctness and decreases the processing time by 80% compared to the global threshold segmentation technique, but the completeness is better in global threshold method than the proposed method. Its future work includes calculation of the diameter of the tumor in 3D MR brain image for treatment planning with high accuracy. *N. Mathur et al.*[5]In their paper presented a fuzzy based edge detection using K-means clustering method. The K-means clustering approach is used in generating various groups which are then input to the mamdani fuzzy inference system. This results in the formation of the threshold parameter to be then fed into the classical sobel edge detector which enhances its edge detection capability using the fuzzy logic. The result shows that fuzzy based k-means clustering increases the performance of classical sobel edge detector along with retaining much relevant information. Its future work includes the application of proposed method on other edge detectors. *S. Khare et al.*[6]. In this paper they proposed a new algorithm for the detection of brain tumor using MRI. The proposed method is implemented using Genetic Algorithm(GA), Curve Fitting and SVM. GA is used to create image segments. The segments obtained after applying GA might be losing some information in their neighboring segments. Curve fitting is applied to properly segment the image without the loss of information. After segmenting the image, features are extracted from the segments. SVM is then used to classify these extracted features. The classified data then helps in determining the tumor using the extracted features. This method is 16.39% accurate and 9.53% precise then the method using Mahalanobis distance. *A.Lakshmi et al.*[7]. In this paper they provided the brain MR image segmentation process which makes the brain tumor diagnosis and analysis easier. The proposed system consists of two main steps: preprocessing and segmentation.

Preprocessing step involves three methods. First method is noise removal using curvelet transform, second one is artifact removal and the third method is skull removal using mathematical morphology. After preprocessing, segmentation is done using spatial FCM. The results presented in the paper are preliminary and quantitative validation on more accuracy and stability of method is still necessary. Its future work includes image segmentation, classification and performance analysis. *Selkar*and *Thakare*[8]in their paper presented watershed and thresholding algorithm for brain tumor  detection and segmentation. The system consists of three stages. Firstly quality of the scanned image is enhanced by removing noise. Secondly thresholding and watershed segmentation is applied to get a high intensity portion called tumor from the whole image. Finally for boundary extraction and to find the size of tumor, edge detection operator is applied. The result shows efficient tumor detection by using thresholding algorithm rather than watershed algorithm and canny edge operator gives efficient boundary extraction results rather than prewitt and Robert operator. *A. Kharrat et al.*[9]In their paper presented an automatic brain tumor segmentation method in MR images. The proposed method constitutes four steps – The first step is image pre-processing. The second step involves feature extraction via the wavelet tansform-spatial gray level dependence matrix(WT-SGLDM). In the third step dimensionality reduction is done using GA and the final step involves classification of reduced features using SVM. The result shows that the proposed method outperforms manual segmentation with Match Percent(MP) measure equal to 97.08% for the malignant and 98.89% for the benign tumors.

The proposed approach outperforms the FCM algorithm with an accuracy rate of 99.69% and 99.36% for benign and malignant tumors respectively and the specificity rate of 99.64% and 99.71% for malignant and benign tumors respectively. *Beham*and *Gurulakshmi*[10]. In this paper they presented a K-means clustering algorithm and Morphological Image Processing. The proposed method consists of three steps: The first step is image enhancement in which outer elliptical shaped object is removed. The second step is morphological process, carried out to extract the required region. The final step is the segmentation using K-means clustering algorithm. This unsupervised method is efficient and less error sensitive and can be applied to minimal amount of data with reliable results compared to supervised methods.

*Gopal*and *Karnan*[11].In this paper they presented a system to diagnose brain tumor through MRI using a hybrid image processing approach such as FCM with GA and Particle Swarm Optimization(PSO). The tumor detection is done in two phases. The first phase involves pre-processing and enhancement using the tracking algorithm to remove film artifacts and median filter to remove the high frequency components. The second phase involves segmentation and classification using GA with FCM and PSO with FCM.  PSO with FCM gives better classification accuracy 92.8% and average error rate 0.059% as compared to GA with FCM where classification accuracy rate is 89.6% and average error rate is 0.078%

### TABLE 1: Comparison of Different Methods

| No. | Author | Year | Methods Used | Advantages | Limitations |
|---|---|---|---|---|---|
| 1 | A.Kharrat et al. | 2016 | DWT-SGLDM for feature extraction. Simulated Annealing (SA) to reduce features size. Stratified K-fold Cross Validation to avoid over fitting.GA-SVM to optimize SVM parameters. SVM to construct the classifier. | Minimum number of features to  classify the normal brain and Pathological brain reduces the cost of classifier. | SA and GA need more computing time which increases asthe number of generation increases. |
| 2 | Ramya and Sasirekha | 2015 | Image denoising: fourth order Partial Differential Equation(PDE). Skull Removal:  Morphological Operators (erosion and dilation). Segmentation: Seed point selection based region growing segmentation. | Fourth order PDE removes noise effectively and favors better edge preservation. The accuracy of detection is high in comparison to watershed segmentation. | Initial seed point selection depends on user ability. |
| 3 | S. E. El-Khamy et al. | 2015 | Fuzzy C-Mean (FCM) and conformed threshold. | Better correctness and reduction in processing time compared to global threshold segmentation method. | Completeness result better in global threshold method than the proposed method. |
| 4 | N. Mathur et al. | 2015 | Fuzzy based sobel edge detection using K-means clustering method | Increases the performance of classical sobel edge detector along with retaining much relevant information. | Computational cost complexity is high |
| 5 | S. Khare et al. | 2014 | GA to create image segments. Curve fitting to properly segment the image without loss of information. SVM to classify extracted features. | More accurate and precise results than the method using Mahalanobis distance | Requires new training set whenever there is change in image database. |
| 6 | A. Lakshmi et al. | 2014 | Noise removal: curvelet transform Skull removal: mathematical morphology Segmentation: spatial FCM | Curvelet transform is an efficient noise removal method that considers both faint linear and curvy linear features. | Results presented are preliminary and requires clinical evaluation. |
| 7 | Selkar and Thakare | 2014 | Image enhancement: Noise removal Segmentation: Thresholding and watershed method Edge detection: Prewitt, Sobel, Canny edge detection operator | Thresholding algorithm detects tumor more efficiently than watershed algorithm and canny edge operator gives efficient boundary extraction results rather than prewitt and robert operator. | Threshold selection using histogram will be inefficient if the histogram peaks are not tall, narrow, and symmetric and separated by deep valley. |
| 8 | A.Kharrat et al. | 2014 | Image pre-processing, feature extraction via the wavelet tansform- | Using the optimal features, the method segments benign and | Applicative where the parameters must be |

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|---|---|---|---|---|---|
| | | | spatial gray level dependence matrix (WT-SGLDM), dimensionality reduction using GA and classification of reduced features using SVM. | malignant tumors with best classification accuracy. | updated. |
| 9 | Beham and Gurulakshmi | 2012 | Image enhancement to remove outer elliptical shaped object. Morphological processing to extract the required region and K-means clustering segmentation method | Less error sensitive and can be applied to minimal amount of data with reliable results compared tosupervised segmentation methods. | K-means clustering does not work well with non-globular cluster. |
| 10 | Gopal and Karnan | 2010 | Pre-processing and enhancement using the tracking algorithm and median filter. Segmentation and classification using with FCM. | PSO with FCM has lower classification error rate and execution time and better accuracy than GA with FCM. | Median filter removes noise to a great extent but at the cost of blurring the Images which in turn makes the edges invisible |

## 3.0. Conclusion

Image processing is widespread in biomedical image analysis and is vital for the study of anatomical structures, tissue volume computation, and diagnosis of abnormalities, pathology, treatment planning and computer-aided surgery. In this investigation various automatic methods for the detection of brain tumor through MRI has been studied.This is done to focus on the future developments of medical image processing in medicine and healthcare. This work will be extended to design new algorithm for detection of brain tumor which will provide more efficient result than the existing methods in near future.

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