An Efficient Technique for Brain Tumor Detection Based on Naïve Bayes (BT) Classification in MR Images

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Abstract: **-** The brain tumor detection is the approach which can detect the tumor portion from the MRI image. To detect tumor from the image various techniques has been proposed in the previous times. The technique which is proposed in this research paper is based on morphological scanning and naïve bayes classification. The morphological scanning will scan the input image and naïve bayes classifier mark the tumor portion from the MRI image. The proposed algorithm is implemented in MATLAB and results are analyzed in terms of PSNR, MSE and accuracy and fault rate.

Index Terms: **- MRI, Naïve Bayes, Morphological Scanning, Brain Tumor**

I. INTRODUCTION

Several lives have been affected because of a common brain disease known as brain tumor. The patients suffering from this disease have not survived in most of the cases. For fighting this disease, several techniques have been proposed such that the knowledge related to medicine can be expanded and one can understand calculations in a better manner such that the tumor can be detected. Due to the high complexity of brain images and the fact that only expert physicians can analyze the tumors, brain tumor detection is a challenging task within medical image processing [1]. For the detection of brain tumor from images, the two most common tests that are applied are Magnetic resonance (MR) imaging and computer tomography (CT) scanning of brain. Further, to perform various treatments, the location of tumor is also identified through this technique. To heal brain tumor, several treatment techniques are proposed today such as radiation therapy, chemotherapy as well as surgery. On the basis of size, type of tumor as well as its grade, the treatment type is chosen. To check whether other parts are being affected by this tumor or not, it is also important to perform certain analysis. When the appropriate treatment method has to be chosen by the doctor, there are certain factors that are to be considered. The possible side effects of a treatment, consideration of complete health and checking whether the central nervous system is affected due to the tumor or not, are few of these factors. Radio imaging is the most commonly applied technique within MRI due to its dynamicity and flexibility [2]. Various pulse sequences and modification in imaging parameters that are based on longitudinal relaxation time (T1) and transverse relaxation time (T2) are used to perform acquisition of variable image contrast. Particular tissue properties are provided in relevance to signal intensities provided on the weighted images T1 and T2. On the basis of pulse sequence parameters, the contrast on MR images is provided. For knowing the details of structures of various organs of the body such as liver, chest and brain, MRI imaging of the body is done. The treatment can be monitored in the patient efficiently with the help of this approach. There are certain steps performed in order to identify the tumor in the patient's body [3]. Pre-processing, segmentation, feature extraction as well as classification are the commonly applied steps. The MRI samples are gathered at the initial stage.

1.1 Preprocessing and Enhancement:

The chances that a suspicious region can be detected can be improved through this initial step being performed in image processing. From the image, the noise is eliminated and finer details are extracted. The accuracy of an image is minimized when noise is present within the MRI image. The noise is removed by applying different filters on the image. The filters are also applied to sharpen the image. Since the detection of boundary of tumor can be done more effectively and easily, it is important to sharpen the image with the help of various low pass filters once the noise has been completely eliminated from the images.

1.2 Segmentation methods:

The process in which the image is broken down into smaller parts or segments is known as image segmentation. The analysis can be performed in easy manner through this step. Several image segmentation methods have been developed over the time. The approach in which the object boundaries are assumed to be defined by the detected edges and which further helps in recognizing these objects is known as edge-based segmentation approach [4]. There is a need to achieve very distinct and closed boundaries to perform direct segmentation which can be done through this approach. False edge detection can occur many times and the partial edges can be joined within an object boundary through edge linking process. The approach in which the bordering pixels present in one area assume to have similar values is known as region based approach. Instead of identifying the edges, the identification of object region is more important in this case. The pixels are compared with the neighboring pixels. The pixels is said to belong to the cluster in the form of one or more of its neighbors in case when the congruence criteria is satisfied.

1.3 Feature Extraction:

To detect brain tumor from images, the extraction of exact tumor image is very important since the structure of brain is very complex [5]. In order to extract certain features, it is important to consider few parameters. The tumor can easily be classified with the help of results achieved from feature extraction process.

II. LITERATURE REVIEW.

Hadeel N. Abdullah [1] In this paper another approach for brain tumor detection and classification is proposed. The proposed approach works in two main parts; the initial segment see the stages of detection the brain tumor from MRI images according to the segmentation tumor from normal tissues and extract feature, the second part utilize ANN to recognize the type of tumor in light of feature extraction. Brain tumor is an uncontrolled mass of tissue might be embedded in the regions of the brain that makes the sensitive functioning of the body to be disabled. Tumor can be divided into two types beginning and malignant tumors. Kindhearted tumors are those which are capable of spreading and affecting the other healthy brain tissue. Malignant tumors are normally becomes outside of brain and called brain growth. A few researchers have chipped away at the issue of brain tumor and lesion segmentation. The iterative watersheds methods are utilized to segment the brain tumor. Others have introduced Fuzzy-based strategies to make more intelligent classification and segmentation decisions. The proposed method developed to extract brain tumor utilizing multi-stage in light of enhanced image and segmentation utilizing limit and watershed to detect the MRI image normal, beginning and malignant. It is accomplish the optimum result in the shortest time.

Nan Zhang [2] In this paper, the multi-kernel SVM (Support Vector Machine) classification, coordinated with a fusion process, is proposed to segment brain tumor from multi-sequence MRI images (T2, PD, FLAIR). The goal is to quantify the advancement of a tumor during a therapeutic treatment. As the procedure develops, a manual learning process about the tumor is done just on the main MRI examination. At that point the follow-up on coming examinations adapts the learning automatically and delineates the tumor. Our method comprises of two steps. The first orders the tumor region utilizing a multi-kernel SVM which performs on multi-image sources and gets relative multi-result. The second one ameliorates the contour of the tumor region utilizing both the distance and the maximum likelihood measures. Our method has been tested on real patient images. The quantification evaluation proves the viability of the proposed method.

Wanhyun Cho [3] This paper displays another half breed speed function expected to perform image segmentation inside the level-set framework. This speed function gives a general form that incorporates the alignment term as a part of the driving force for the proper edge direction of an active contour by utilizing the likelihood term derived from the region partition scheme and, for regularization, the geodesics contour term. In the first place, we utilize an external force for active contours as the Gradient Vector Flow field. This is processed as the diffusion of gradient vectors of a gray level edge outline from an image. Second, we partition the image domain by progressively fitting statistical models to the intensity of every region. Here we adopt two Gaussian distributions to model the intensity distribution of within and outside of the evolving curve partitioning the image domain. Third, we utilize the active contour model that has the computation of geodesics or minimal distance curves, which allows stable boundary detection when the model's gradients experience the ill effects of huge variations including gaps or noise. At last, we test the accuracy and robustness of the proposed method for different medical images. Test results demonstrate that our method can properly segment low contrast, complex images.

Sahar Ghanavati [4] Automatic detection of brain tumor is a troublesome undertaking because of variations in type, size, area and shape of tumors. In this paper, a multi-methodology framework for automatic tumor detection is displayed, fusing distinctive Magnetic Resonance Imaging modalities including T1-weighted, T2-weighted, and T1 with gadolinium contrast agent. The intensity, shape deformation, symmetry, and surface features were extracted from each image. The Ada Boost classifier was utilized to select the most discriminative features and to segment the tumor region. Multi-modular MR images with simulated tumor have been utilized as the ground truth for training and validation of the detection method. Preparatory results on simulated and patient MRI demonstrate 100% successful tumor detection with normal accuracy of 90.11%. As of now, we are validating our method on multiple healthy and pathological patient data with variable tumor characteristics. These segmented real data will be included in the training data set keeping in mind the end goal to improve the classification performance.

Nelly Gordillo [5] The author show proposed challenge in brain tumor segmentation method which considers human knowledge. The master knowledge and the features derived from the MR images are coupled to define heuristic standards aimed to the design of the fuzzy approach. To assess the unsupervised and fully automatic segmentation, intensity-based target measures are defined, and another method for getting membership functions to suit the MRI data is introduced. The proposed brain tumor segmentation approach additionally introduced another way to automatically define the membership functions from the histogram. The proposed membership functions are designed to adapt well to the MRI data and proficiently isolate the populations. The segmentation system is simplified since neither pre or post-processing in addition to skull stripping is important shortening computational times. The proposed approach is quantitatively comparable to the most accurate existing methods, despite the fact that the segmentation is done in 2D. As a general conclusion of the conducted tests, the proposed approach is quantitatively comparable to the most accurate existing methods, despite the fact that the segmentation is done in 2D. Be that as it may, when this approach is extended to perform the classification in 3D, the accuracy will be improved when the correlation between the slices is performed.

A. Kharrat [6] In this paper, an efficient detection of brain tumor has been introduced. It's based on mathematical morphology, wavelet transform and K-means technique. The calculation reduces the extraction steps through enhancement the contrast in tumor image by processing the mathematical morphology. The segmentation and the localization of suspicious regions are performed by applying the wavelet transforms. At long last K means calculation is implemented to extract the tumor. Results are displayed, utilizing a real image of brain tumor as illustrative example, which indicate noteworthy concordance, comparing with expert result. Although the performances of proposed calculation has been demonstrated. The tumor extraction paves the way for the expert to decide the degree of malignancy or aggressiveness of a brain tumor. Be that as it may, it isn't always simple to classify a brain tumor as "considerate" or "malignant" the same number of elements other than the pathological features contributes to the outcome. This will be the subject of future research.

Shonket Ray [7] In this work the authors compare the accuracy of two-dimensional 2D and three-dimensional 3D implementations of a computer-aided image segmentation method to that of doctor observers utilizing manual illustrating for volume measurements of liver tumors imagined with symptomatic contrast-enhanced and PET/CT-based non-contrast-enhanced PET CT filters. The method assessed is a hybridization of the watershed method utilizing spectator set markers with a gradient vector flow approach. This method is known as the iterative watershed segmentation IWS method. Beginning assessments are performed utilizing programming phantoms that model a range of tumor shapes, noise levels, and noise qualities. IWS is then connected to CT image sets of patients with identified hepatic tumors and compared to the physicians' manual outlines on similar tumors. The repeatability of the physicians' measurements is additionally assessed. Our data indicate that allowing the operator to choose the "best result" level iteration outline from all generated outlines would likely give the more accurate volume for a given tumor as opposed to automatically choosing a particular level iteration outline with intensity features. We utilize different likeness measurements to assess quality and robustness of these selected features for PF tumor segmentation in MRI for ten pediatric patients.

III. RESEARCH METHODOLOGY.

This research work is based on the detection of brain tumor detection. The technique of brain tumor detection is based on the following step:-

3.1 Morphological Operations:

The process through which the structure or shape of an object can be deformed or reconstructed is known as morphology. For the representation of shape of an object, the operations that are applied on binary images are known as morphological operations. While performing pre or post processing, these operations are applied such that the shape of objects or areas can be known in more appropriate way. Following are few of the most commonly used morphological operations:

3.2 Erosion:

The operation with the help of which the boundaries of areas of front-end pixels are eroded from the binary images is known as erosion. In terms of size and holes present within it, the regions of foreground pixels are shrunk. There are two inputs given here [6]. The image is eroded within the initial input and the structuring element is given as the second input. The structuring element is superimposed on the top of input image such that the erosion of binary image can be calculated. Thus, the origin of structuring element and input pixel coincide with each other.

3.3 Dilation:

The approach through which the holes are filled by adding the pixels to the boundaries of objects present within the image is known as dilation. Two pieces of data are taken as input in this operator. Image is dilated in the initial one and elements are structured in the second one. On the input image, the structuring element is superimposed for each background pixel such that the input pixel position and structuring element coincide [7]. Increase the area of foreground pixels is the basic effect of dilation on the binary image. There is a complete closing up of the operation however, in this operation which is its only demerit.

There are several classifiers used in the process of detection brain tumor from images. A data structure in the form of a tree is created within a decision tree classifier. On the basis of one particular feature, each interior node that includes decision criteria is based. The entropy reduction that presents the purity of samples is used to calculate the features that are in relevance to classification [8]. The classifier through which two classes are separated using a hyper plane is known as Support Vector Machine (SVM). From the empirical data, an optical function can be calculated in case when the classes are separated by hyper plane. A basic feed forward based artificial neural network classifier was introduced known as multi-layer perceptron classifier. For performing simple functions, a single hidden layer is used here at first. Further, to improve the classification performance, two hidden layers were included here. For every data set, different hidden units were selected. Across a number of trails, the numbers of hidden neurons were identified. Back propagation algorithm was used to train the neural network.

3.4 Naïve Bayes Classifier:

Naive Bayes algorithm is one of the most effective methods in the field of text classification, but only in the large training sample set can it get a more accurate result. The requirement of a large number of samples not only brings heavy work for previous

manual classification, but also puts forward a higher request for storage and computing resources during the computer post-processing.

Naive Bayes classifier is a simple probabilistic classifier based on applying Bayes' theorem (from Bayesian statistics) with strong (naive) independence assumptions. A more descriptive term for the underlying probability model would be "independent feature model". In simple terms, a naive Bayes classifier assumes that the presence (or absence) of a particular feature of a class is unrelated to the presence (or absence) of any other feature.

The morphological scanning technique will scan the image and technique of naïve bayes is applied which mark the tumor in the image. The classifier that includes all independent attributes when the value of class variable is given is known as Naïve Bayes classifier. Conditional independence is another name for this classifier and it is known to be the easiest form of Bayesian network [9]. Here, the Bayes' theorem is applied along with the naïve assumption that shows the independence amongst every pair of features within the set of supervised learning algorithms. Following relationship is stated by the Bayes' theorem:

$$P(y|x_1, \dots, x_n) = \frac{P(y)P(x_1, \dots, x_n|y)}{P(x_1, \dots, x_n)}$$

Here, y is a class of variable and from x_1 to x_n a dependent feature vector is included. **PSNR and MSE**: PSNR (peek signal noise ratio) MSE (mean square error)

PSNR is used to measure the quality of reconstruction of lossy and lossless compression (e.g., for image compression). The signal in this case is the original data, and the noise is the error introduced by compression. When comparing compression codecs, PSNR is an *approximation* to human perception of reconstruction quality. Although a higher PSNR generally indicates that the reconstruction is of higher quality. Here, MAX_I is the maximum possible pixel value of the image.

Naïve Bayes BT

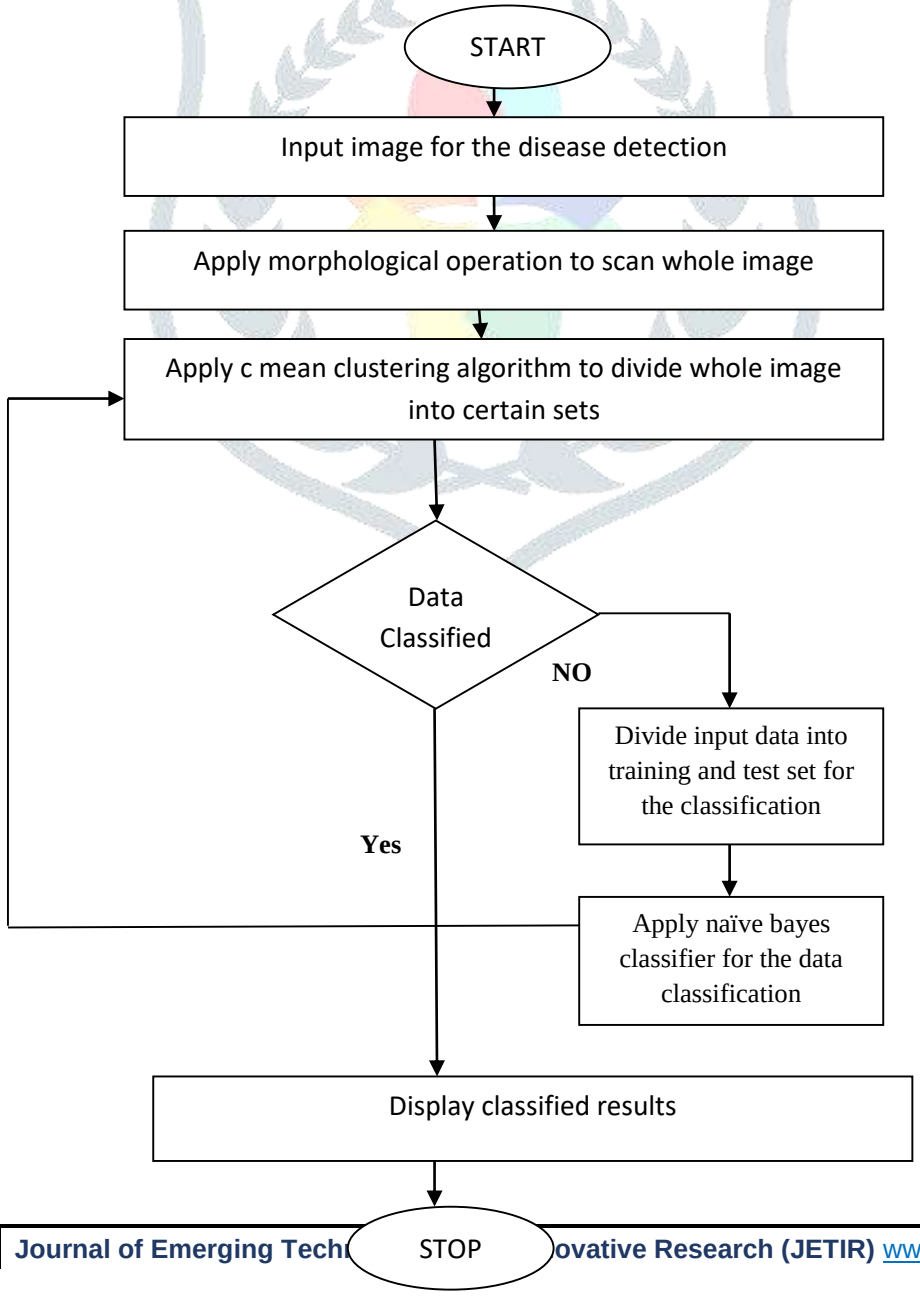

Fig 1: Proposed Flowchart

IV. RESULT AND DISCUSSIONS.

This research work is based on the brain tumor detection. Input the image into patches using sparse reconstruction. To detect tumor from the MRI images technique of classification is applied. Technique of clustering to cluster similar and dissimilar pixels. Input the test data for tumor detection. Apply the morphological operations. Divide input class into training set then classified the data. The technique of naïve bayes classifier mark the tumor portion in the image.

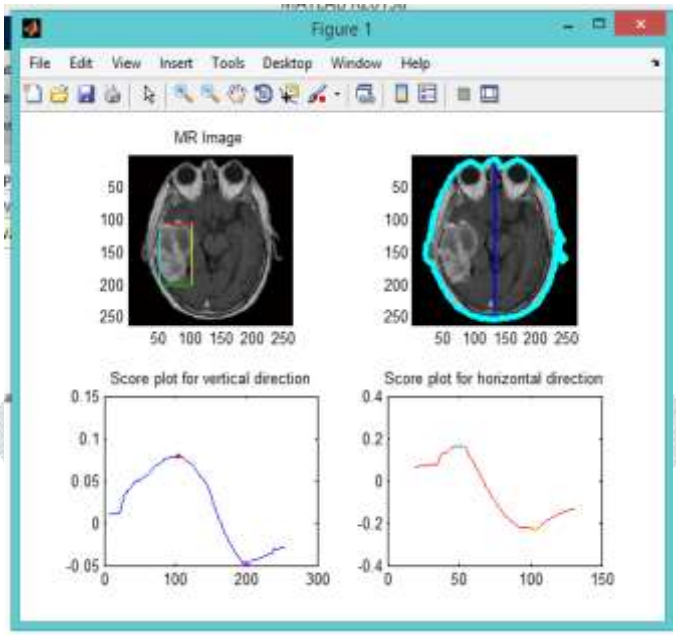

Fig 2: Naïve Bayes Classifier

As shown in figure 2, the technique of naïve bayes classifier is applied which mark the tumor portion on the image. The vertical and horizontal position is also calculated from the input MRI Image

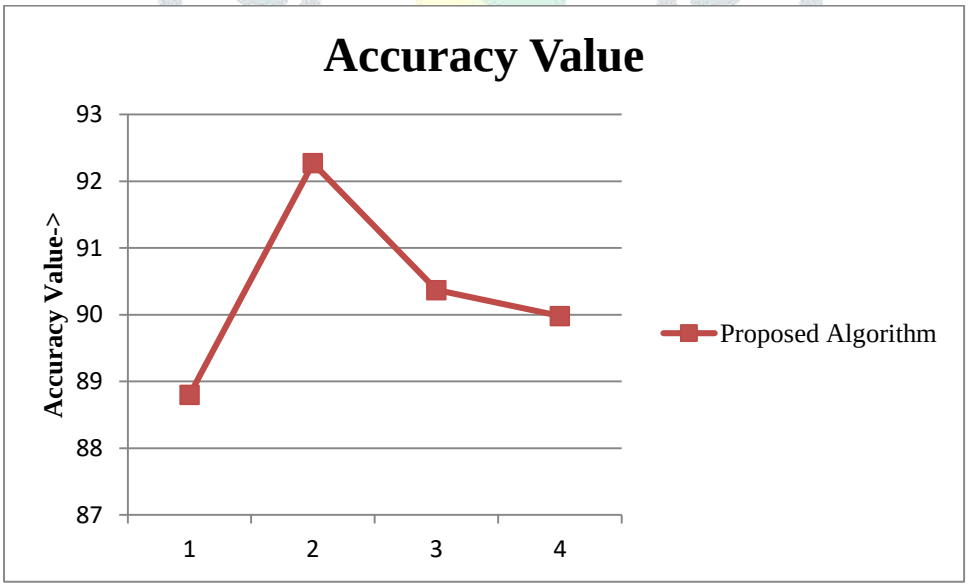

Fig 3: Accuracy Value

As shown in figure 3, the accuracy value of the proposed algorithm is compared for the performance analysis. It is analyzed that proposed algorithm has high accuracy as compared to existing algorithm.

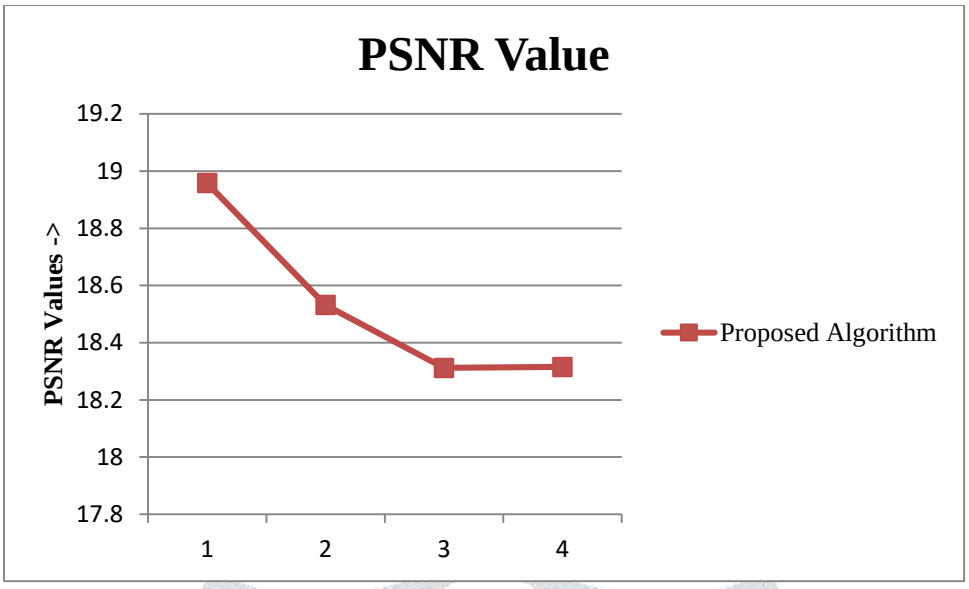

Fig 4: PSNR Value

As shown in figure 4, the PSNR value of the proposed and existing algorithm is compared for the performance analysis. It is analyzed that PSNR value of proposed algorithm is high as compared to existing algorithm

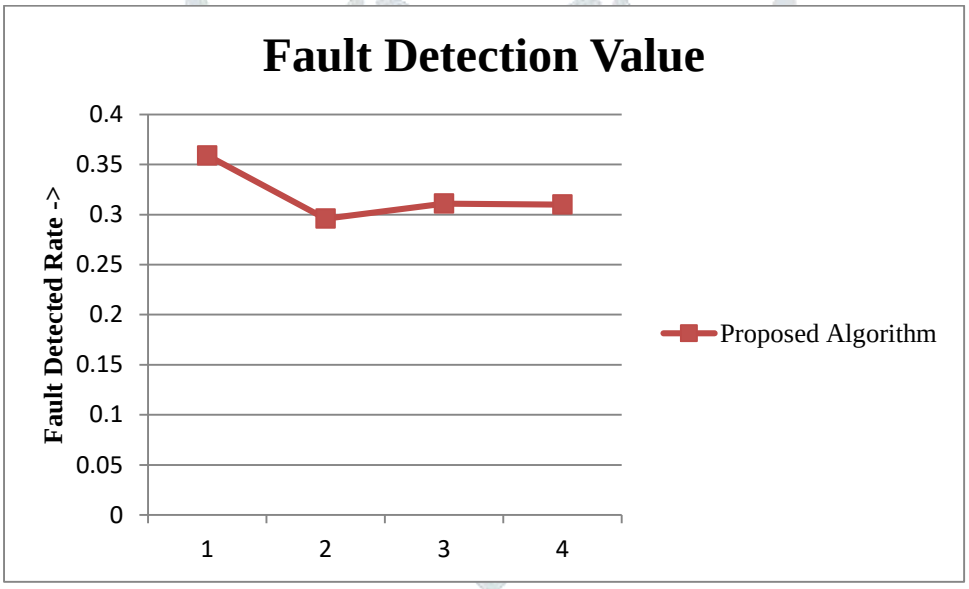

Fig 5: Fault Detection

As shown in figure 5, the Fault Detection value of the proposed algorithm is compared for the performance analysis. It is analyzed that FD value of proposed algorithm is high as compared to existing algorithm.

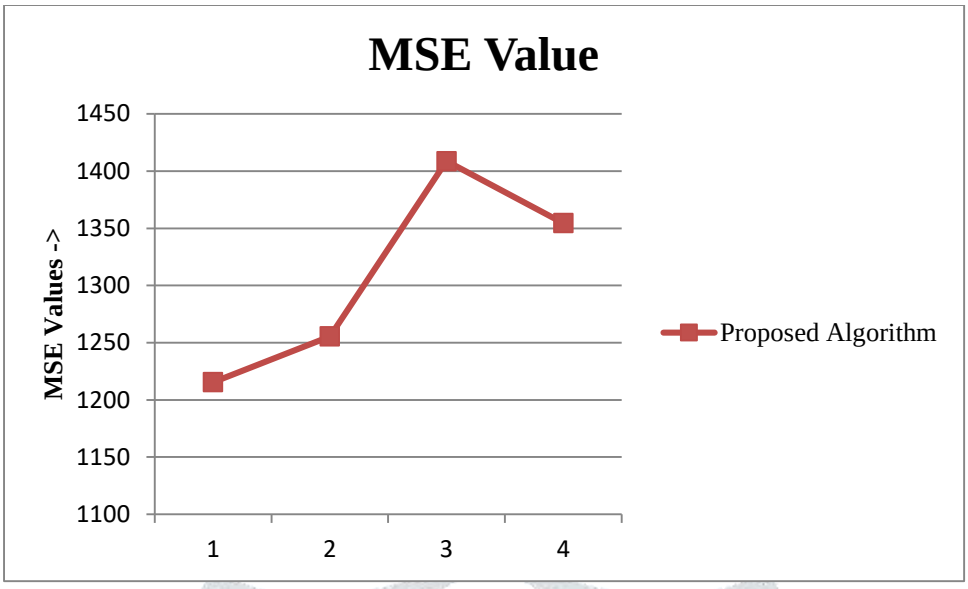

Fig 6: MSE Value

As shown in figure 6, the MSE value of the proposed algorithm is compared for the performance analysis. It is analyzed that MSE value of proposed algorithm is less as compared to existing algorithm

V. CONCLUSION.

In this work, it is concluded that image processing is the technique which can process information stored in the form of pixels. The brain tumor detection is the technology which can detect tumor portion from the MRI image of brain. In this research work, novel technique is proposed which is based on the morphological operation and naïve bayes classifier. The performance of proposed algorithm is compared with existing and it is analyzed that proposed algorithm performs well in terms of PSNR, MSE, Accuracy and Fault detection rate, Also calculate overlapping area using dice coef which give different parameter values of peek signal noise ratio and magnified signal error.

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