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Development of an Efficient Clustering Technique for Brain Tumor Detection for 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 major challenge of robust brain tumor nuclei/cell detection is to handle significant variations in cell appearance and to split touching cells. 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 qualitatively and quantitatively in various parameters like false positive rate, false negative rate, execution time, PSNR, MSE, Accuracy and Fault Detection and also calculate overlapping area with dice coef. The proposed method has been tested on data set with more than 25 slide scanned images. This proposed method achieved accuracy with 86% best cell detection.

Keywords- MRI, Naïve Bayes, Morphological Scanning, Brain Tumor, Clustering.

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.

a. 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.

b. 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.

c. 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

Kim Mey Chew et.al (2018) proposed bio-signal processing and 2-dimentional representation of near- field RADAR microwave analysis with the help of mono-static ultra-wideband fabric for the detection of brain tumor [10]. Brain tumor simulation is done by the development of brain phantom with tumor by using a new composition of agar-agar, glucose and liquid based on relative permittivity of the human brain. During this simulation process the planar y-axis and the reflected signals from phantom were collected. For the determination of reflection point five regular windows and a proposed superposition technique function were used. Accordingly, the linear establishment and contrast improvement methods were used for 2D data representation. The study concludes that the brain tumor can be detected using microwave signals performed at a particular level of tumor depth and high relative permittivity decreases the amount of transmitted signals.

Navpreet Kaur (Student) et.al (2017) analyzed Magnetic Resonance Imaging (MRI) technique for the detection of brain tumor [11]. It shows the complex structure of brain cells along with the bony network and suspected solid growth if any. If we want to study the growth we need to study the fragmentation process, which is a huge disadvantage. This disadvantage can be solved by using K-means clustering algorithm. For the extraction of segmented brain tumor from its surroundings a Sobel edge detection is used. In K- means clustering technique, the number of clusters is counted by computing them on the peaks of histogram. The size and location can be analyzed by the segmented part of the binary image. The final fragmented part is then use to analyze size and perimeter of the tumor. It concludes that the brain tumor can be detected using MRI and self- adaptive K- means clustering techniques.

Animesh Hazra et.al (2017) reviewed detection and localization of tumor region present in the brain by using patient's MRI [12]. It contain three levels namely, pre-processing, segmentation and edge detection. Pre-processing converts the original image into gray scale image and eradicates noise if any which further followed by the edge detection using Sobel and Canny algorithms with technique of image enhancement. The segmentation is applied to display the tumor affected region. Lastly, the K-means algorithm is used for the image clusters. It results the identification of the brain tumor is done efficiently using MRI and K- means algorithms. In order to detect the tumor more accurately the algorithms can be improvised.

Saumya Chauhan et.al (2018) proposed pre-processed median filtering MRI brain images [13]. In order to separate the lesion from image, a color based segmentation and edge detection is done. Histogram of oriented gradients and gray

level co-occurrence matrix is used to represent the images. The respected extracted features are stored in the transactional database to classify the tumor into normal benign. The classified accuracy is being calculated 86/6%. This summarized that the proposed system help to know about the type of brain tumor and its further treatment.

Reema Mathew A et.al (2017) analyzed that the Magnetic Resonance Imaging (MRI) is the effective technique of the brain tumor detection and classification [14]. This classification is done in various steps like pre-processing, filtration of sound, feature extraction and segmentation. These methods preprocessed the MRI brain image using anisotropic diffusion filters. The discrete wavelet transforms are extracted in the feature extracted step. These features are further given as the input to the segmentation step. A support Vector Machine was used segmentation and tumor classification. Hence, it concludes that the accuracy of proposed system is 86%. The validation of this method with the recent results can be used in the future proposals.

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:-

Step 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:

a. 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.

b. 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.

Step 2: Naïve Bayes Classifier:

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.

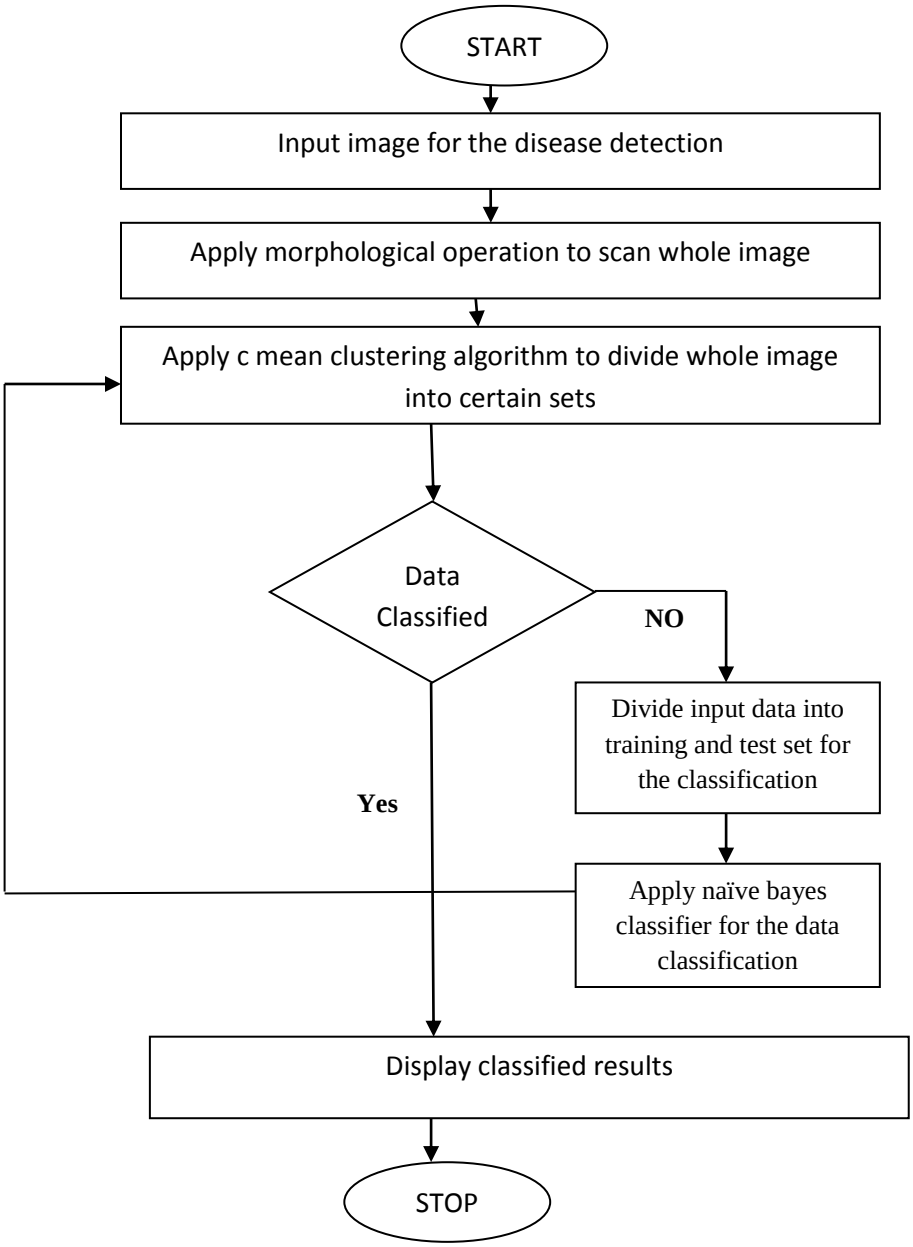

Fig 1: Proposed Flowchart

IV. RESULT AND DISCUSSIONS

This research work is based on the brain tumor detection. To detect tumor from the MRI images technique of classification is applied after the morphological operation. The technique of naïve bayes classifier mark the tumor portion in the image

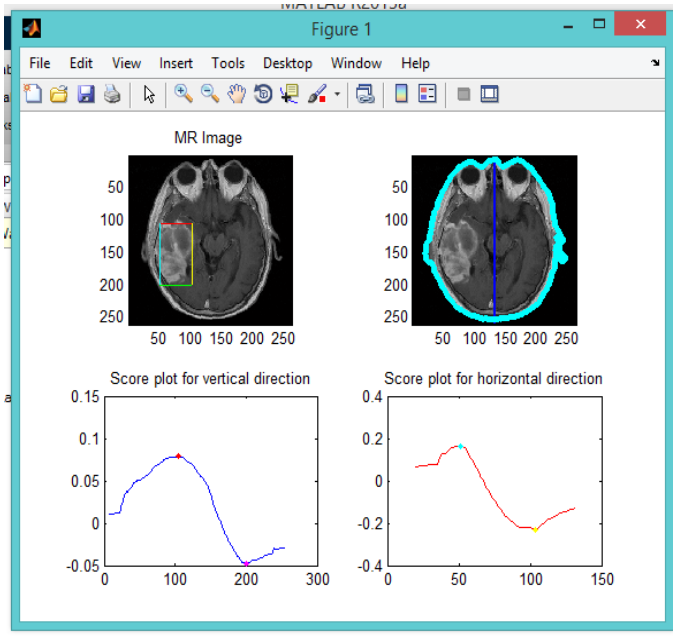

Fig 2: Naïve Bayes Classifier

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

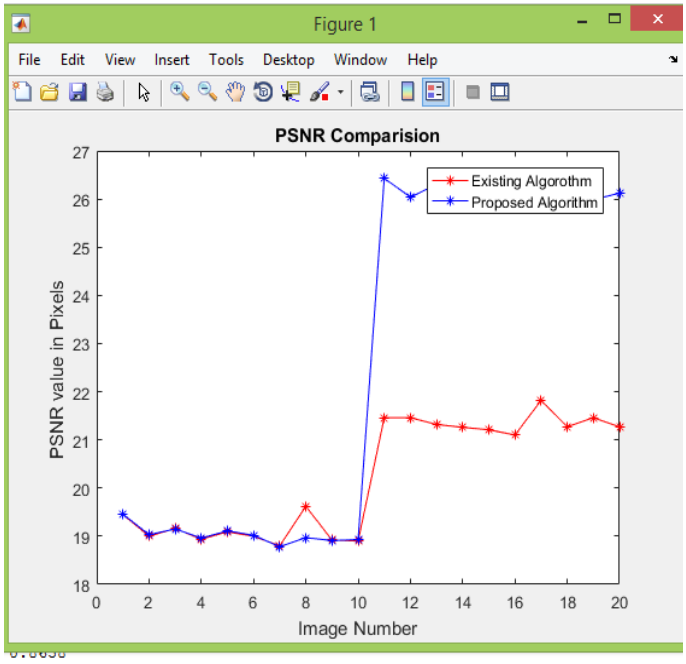

Fig 3: PSNR Comparison

As shown in figure 3, 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

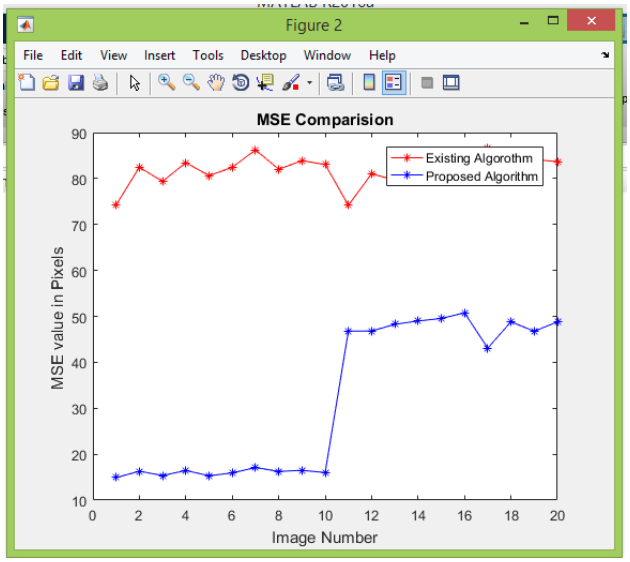

Fig 4: MSE Comparison

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

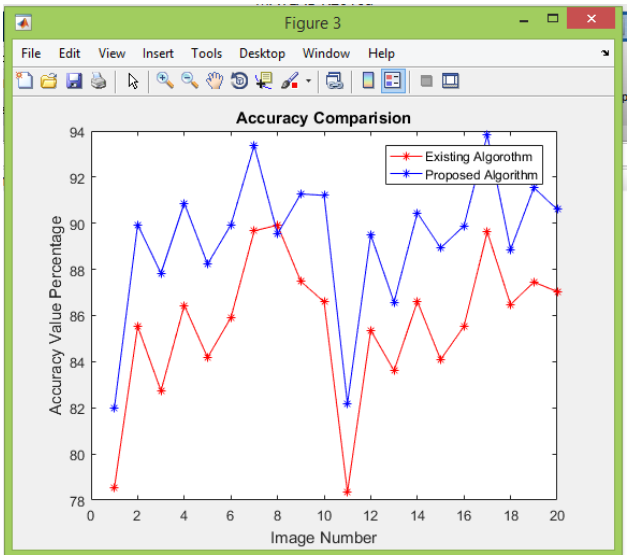

Fig 5: Accuracy Comparison

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

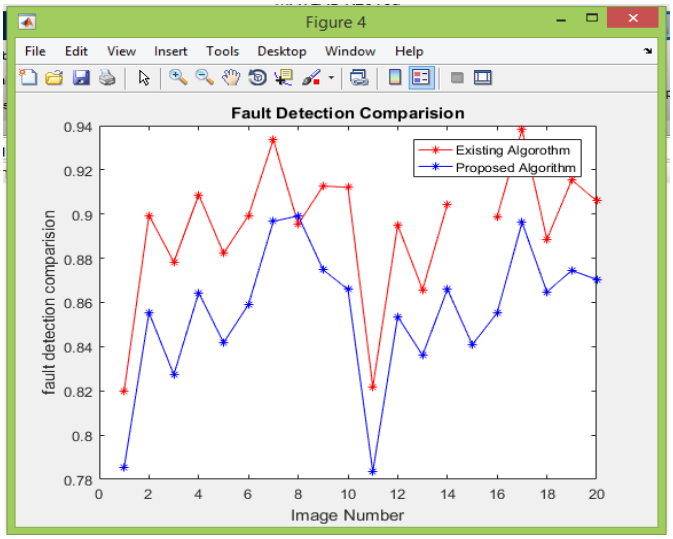

Fig 6: Fault Detection Comparison

As shown in figure 6, the fault detection rate value of the proposed and existing algorithm is compared for the performance analysis. It is analyzed that proposed algorithm has high fault detection 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 and accuracy.

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