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Detection of Brain Tumor Using K-means++ Algorithm

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Abstract: ***Image processing plays an essential role in Medical field. Brain tumor is an abnormal growth of brain cells within the brain. The detection of brain tumor involves different stages such as Image preprocessing, Enhancement, Segmentation, Feature extraction and Classifier. In normal detection methods it is not possible to detect the tumor near the bones. Hence designing an optimal brain tumor detection algorithm is an important factor. The existing works failed to overcome this problem efficiently. So by using K-means++ algorithm we can overcome this problem. In this work, we capture the image & pre-process it by using filters (Adaptive Local filter, Median filter, Wiener filter, Average filter, Gaussian filter).The obtained result is further enhanced by Histogram Equalization technique. Though we are having several image enhancement techniques, we choose AHEQ (Adaptive Histogram Equalization) for our proposal. After that Segmentation can be done to detect the tumor from MRI image using K-means++ algorithm. It is observed that the proposed method gives better result in comparison to other techniques.***

Keywords: MRI Brain Image, Histogram Equalization, K-means++ algorithm, Image Segmentation and Enhancement.

1.INTRODUTION

Image processing plays a wide role in various fields like medical images, satellite images and also in industrial applications. Our paper focuses on medical image applications. From past few years, we could not find the tumor which is present near the bone. Detection of brain tumor is a challenging problem due to complex structure of brain. To ease the difficulty, we are using K-means++ algorithm. This algorithm helps to find the tumor which is present near the bone .Detection of brain tumor involves different stages such as image capture, image preprocessing, segmentation, enhancement, feature extraction and classifier.

FLOW CHART

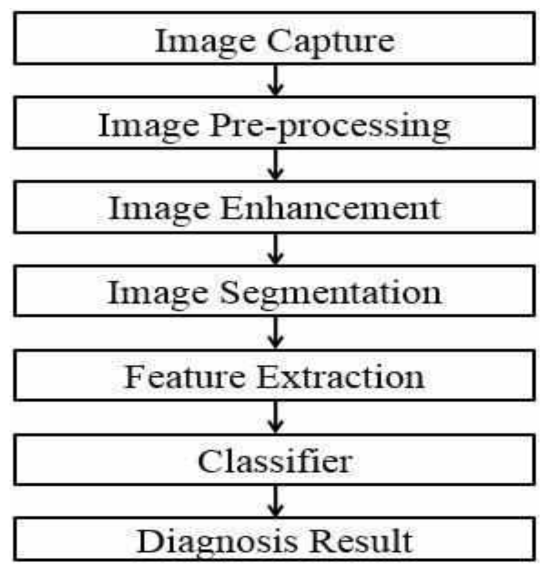

Fig.1 Flow chart

2.PROPOSED METHOD

The basic purpose of this paper is to show only the tumor region. In this paper, different types of MRI images are used for tumor detection. The complete procedure for the proposed algorithm is given below.

A) Image Capture:

This is the first step of the proposed method.

Initially the MRI scan of the brain is captured.

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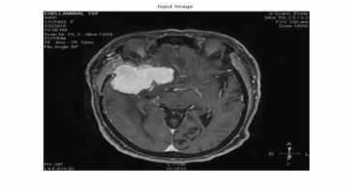

Fig2:Input image

B) Pre-processing:

Generally in all image processing techniques we need to add some noises to the captured image to obtain efficient output without loss. In this step Gaussian noises are removed from the captured images using Weiner filter and morphological operations (Erosion &Dilation).

Erosion:

It is used to remove the excessive edges in the input image.

Dilation:

It is used to include the excessive edges in the input image.

Gaussian Noise:

Gaussian noise in digital images arise during acquisition e.g. sensor noise caused by poor illumination and/or high temperature, and/or transmission e.g. electronic circuit noise.

A typical model of image noise is Gaussian, additive, independent at each pixel, and independent of the signal intensity, caused primarily by Johnson–Nyquist noise (thermal noise), including that which comes from the reset noise of capacitors ("KTC noise"). Gaussian filtering is highly effective in removing Gaussian noise from the image.

Noise Removal:

In this step added noise is removed to obtain a proper output.

Wiener Filter:

The purpose of the Wiener filter is to filter out the noise that has corrupted a image. This filter is based on a statistical approach. Mostly all the filters are designed for a desired frequency response. Wiener filter deals with the filtering of an image from a different view. The goal of wiener filter is reduced the mean square error as much as possible. This filter is capable of reducing the noise and degrading function. One method that we assume and we have knowledge of the spectral property of the noise and original signal. We used the Linear Time Invariant filter which gives output similar as to the original signal as much possible.

Characteristics of the wiener filter are:

a. Assumption: signal and the additive noise are stationary linear-random processes with their known spectral characteristics.
b. Requirement: the wiener filter must be physically realizable, or it can be either causal
c. Performance Criteria: There is minimum Mean Square Error [MSE].
The Fourier domain of the Wiener filter is

$$G(u,v) = \frac{H^*(u,v)}{|H(u,v)|^2 P_s(u,v) + P_n(u,v)} \longrightarrow \text{eq(1)}$$

Where $H^*(u, v)$ = Complex conjugate of degradation function

$Pn\ (u, v)$ = Power Spectral Density of Noise

$Ps\ (u, v)$ = Power Spectral Density of non-degraded image $H\ (u, v)$ = Degradation function

PERFORMANCE PARAMETERS

For comparing original image and uncompressed image, we calculate following parameters:

Mean Square Error (MSE): The MSE is the cumulative square error between the encoded and the original image defined by:

$$MSE = \frac{1}{mn}\sum_{0}^{m-1}\sum_{0}^{n-1}\|f(i,j) - g(i,j)\|^2 \longrightarrow \text{eq(2)}$$

Where, f is the original image and g is the uncompressed image. The dimension of the images is m x n. Thus MSE should be as low as possible for effective compression.

Peak signal to Noise ratio (PSNR): PSNR is the ratio between maximum possible power of a signal and the power of distorting noise which affects the quality of its representation. It is defined by

$$PSNR = 20\log_{10}\left(\frac{MAX_f}{\sqrt{MSE}}\right) \longrightarrow \text{eq(3)}$$

Where, MAX is the maximum signal value that exists in our original "known to be good" image.

Bit per Pixel (BPP): It is defined as number of bits required to compress each pixel. It should be low to reduce storage requirement.

Signal to Noise Ratio is defined by the power ratio between a

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signal and the background noise.

$$SNR = \frac{P_{Signal}}{P_{Noise}} \longrightarrow eq(4)$$

Where, *P* is average power. Both noise and power must be measured at the same points in a system, and within system with same bandwidth.

C) Image Enhancement:

The main function of image enhancement is to carry out the hidden part from an image or to enhance the low contrast image. The quality of the image gets better by contrast manipulation. A very well-liked performance for contrast enhancement is Histogram Equalization (HE). The most part of techniques is used, due to simplicity and moderately better performance on images.

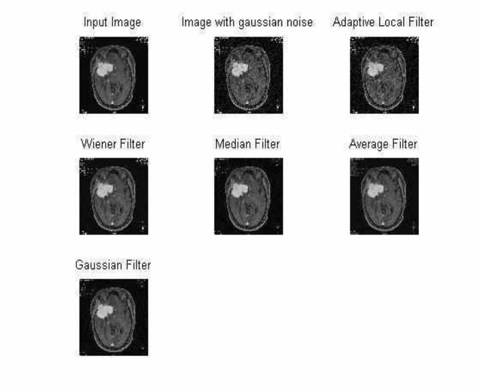

Fig.3 Output of preprocessing

Equalization techniques:

Histogram Equalization and their complex methods are measured for contrast enhancement of the images.

Histogram Equalization:

Histogram Equalization is a technique for adjusting image intensities to enhance contrast. The histogram of an image mostly represents the comparative frequency of occurrence of the various gray levels in the image.

$$P_n = \frac{[illegible]}{[illegible]}$$

equalisation. Histogram Equalization is classified into two categories: Adaptive and non adaptive. In the non adaptive each pixel is customized by applying the same pattern of calculation that uses the histogram of complete original image. In order to works with better result for the image that has details hidden in dark regions.In the adaptive each pixel is customized based on the pixels that are in a region neighbouring pixel. This region is called contextual region. If an image of (n x n) pixels, with k intensity levels and the size of contextual region is (mxm). Then the time required for calculation is O (n^2(m+k)), Better results are obtained through instead use of the histogram of neighbourhood pixels from moving window only four nearest grid points.

$$\left[a = \frac{[illegible]}{[illegible]} \quad b = \frac{[illegible]}{[illegible]} \right] \longrightarrow eq(5)$$

D) Image Segmentation:

After image enhancement step, MRI image is segmented by using k-means++algorithm.Image segmentation is the important process of image analysis and image understanding It is defined as the process of partitioning the digital image into different sub regions of homogeneity. The objective of image segmentation is to cluster pixels into salient image regions i.e., regions corresponding to individual surfaces, Objects or natural parts of objects. Segmentation might be used for object recognition, image compression, image editing, etc. The quality of the segmentation depends upon the MRI image. In the case of simple images the segmentation process is clear and effective due to small pixels variations, whereas in the case of complex images, the utility for subsequent processing becomes questionable which are done in multiple fashions. Segmentation includes two steps: Dividing or merging existing regions from the image and growing regions from seed points. The result of segmentation is a set of segments that collectively cover the entire image. Each of the pixels in a region are similar with respect to some characteristics are computed property, such as color, intensity or texture. Adjacent regions are significantly different with respect to the same characteristics.

n=0,1,.....L-1
Consider an image with gray levels in the range [0, L-1], probability distribution function of the image can be computed as:

$p(r_k) = \frac{��}{�}$

n=0, 1….L-1
Where, r_k is the k^{th} gray level and n_k is the number of pixels in the image having gray level r_k.

Adaptive Histogram Equalization:

Adaptive Histogram Equalization (AHE) is a terrific contrast enhancement method for both natural images and medical images. The method engages is applied to each pixel in histogramK-means++Algorithm:

In segmentation process we use K-means clustering algorithm which one of the most popular techniques in the field of pattern recognition, data mining and unsupervised learning to detect brain tumor. Although, it gives no guarantee (theoretically) about accuracy, its speed and simplicity are very appealing for practical applications. K-means algorithm is significantly sensitive to initial selection of cluster centers. Usually algorithm begins with k arbitrary centers, typically chosen uniformly at random from the data points. However, to reduce sensitivity of K-means towards initialization of cluster centre, K-means is run multiple times and only one that minimize the sum of squared distances is selected.

This method performs better but still does not guarantee accuracy. There are many datasets for which K-means generates arbitrary bad clustering. I assume, like me most of you also would have struggled with initialization of K-means algorithm. K-Means++ algorithm overcomes this weakness of K-means and makes it much more effective. K-means++ algorithm proposes a simple probabilistic means of initialization for K-means clustering that not only has the best known theoretical guarantees on expected outcome quality, it reportedly works very well in practice.

The Exact Algorithm is as Follows:

We propose a specific way of choosing centres for the k-means algorithm. We define the following algorithm, which we call k-means++.

1) Numbers of clusters must be known to be K.

2) K number of cluster centres such that they are farthest apart from each other.
3) Consider each data point and assign it to the cluster which is closest.
4) Recalculate cluster centres by finding mean of data points belong to the same cluster.
Now repeat steps 3&4 until no change in its cluster centres.

E) Feature Extraction:

Feature extraction in image processing is technique of redefining a large set of redundant data into a set of features of reduced dimension. This transformation of input data into the set of features is called feature extraction

F) Classifier:

The simplest approach is the minimum distance classifier which has its name implies computes the (Euclidean) distance between the unknown and each of the prototype vectors. It chooses the smallest distance to make a decision.

Minimum distance classifier:

It Suppose that we define the prototype of each pattern class to be the mean vector of the patterns of that class:-enhanced by using Adaptive histogram equalization and segmented by using K-means++algorithm. k-means algorithm is less sensitive to noise and initialization process and also tumor is not deducted efficiently when it is near to the bone but, in k-means++algorithm drawback in K-means algorithm can be overcome.

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$M_j = \frac{1}{N_j}\sum_{x \in w_j} X_j$ eq (6)

j=1,2,3,…..W

Where N_j is the number of pattern vectors from class w_j and the summation is taken over these vectors. W is the number of pattern classes.

3. CONCLUSION

In this project an efficient K-means++ algorithm for brain tumor image segmentation was proposed. Brain tumor images are

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