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An Approach for Detection of the Components in Brain MRI Using Vector Quantization and Morphological Operations based Segmentation

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Abstract— Image segmentation is a technique in image processing where an image is divided into meaningful structures to simplify its representation. Vector quantization helps to map the continuous pixel of input space to discrete pixels in the output image. Here the advantage is to minimize the information loss. The approach in this paper focuses on the spatial as well as the gray level value of the image to effectively derive beneficiary result. The detection of the important components in brain MRI image has become a challenging task in terms of the performance of different existing algorithms. Here the proposed method involves preprocessing of the brain image with tumor, vector quantization, adaptive binarization, application of morphological operations. The calculation of the tumor area is done using the proposed algorithm and manually using active contour method where the accuracy of the proposed method is calculated. In this paper the method extracts the main components of the brain with tumor which includes the skull, the tumor, the gray matter and the white matter. The method could easily extract the tumor of any size from a brain image with tumor having more accuracy than any other existing methods.

Keywords— Image segmentation, Vector Quantization, Adaptive binarization, Morphological operations, MRI images, Contour method, preprocessing.

1. INTRODUCTION

Image segmentation being a part of image processing can be viewed as the technique where the image can be clustered based on the intensity value of pixels [1], similarity of data points [2] etc. The segments obtained after segmentation are meaningful pieces which have similarity in features and properties. Image segmentation plays a crucial role in numerous biomedical imaging applications, clinical operations etc. for diagnosing various diseases using scientific data. High computational complexity is required in this stream where substantial amount of time is needed which limits the capability. Researches that has focused on parallel processing models supports biomedical image segmentation. The special case of biomedical image segmentation is object categorization where spectral clustering is focused on.

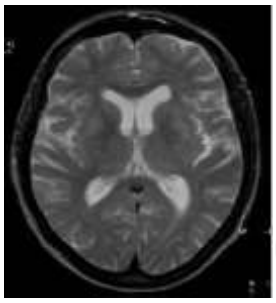
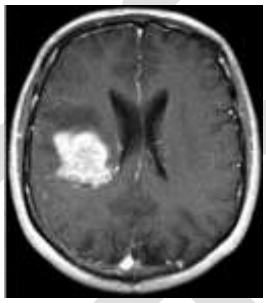
In the case of enormous amount of data, space is becoming more enough of consideration. So, inorder to store the information about images it requires image compression technique incorporated with the image segmentation. Vector Quantization (VQ) is a technique of image compression used in accordance with image segmentation where continuous input space is projected on a discrete output space while the information loss will be minimized [3]. Vector quantization has been formed as an efficient encoding technique because it's an infeasible ability for exploiting relationship between the pixels [4]. VQ have mainly four stages namely training set selection, vector formation, codebook generation and quantization [5].

Medical imaging can be viewed as the technical approach for studying the interior especially the tissue wise analysis of the important parts of human body. Other human body structures are made known to experts using medical imaging technology. Medical imaging modal quality as in MRI, CT scan etc. mostly depend on the computer digital image which helps the experts to analyze inner portion of the body parts [6][7].

All parts of the body especially the important parts such as the heart, lungs, kidney etc. are controlled by the brain cells. Hence brain is a vital organ of human body [8] [9]. Brain is the most anterior part of the central nervous system where tumor is an intracranial solid neoplasm. Tumor is actually caused due to abnormal and uncontrollable cell division in brain. Abnormalities causing to the brain which are deadly and intractable diseases named as brain tumor. MRI scan can be used to obtain the images of the brain.

2. RELATED WORKS

Many methods have been proposed for human brain MRI image segmentation. The brain tumors along with various parts of the brain are extracted by considering tumor pixel's centroid from other components of the brain. In [10], two unsupervised methods are proposed for MRI segmentation based on SOM neural network referred as HFS_SOM (Histogram Fast Segmentation Self Organizing Map) and EGS_SOM (Entropy-Gradient Segmentation Self Organizing Map). The HFS_SOM extracts the information from volume image histogram where as in EGS_SOM first and second order statistics are extracted as the feature data. In [11], GHSOM (Growing Hierarchical Self Organizing Map) and multi objective-based feature selection methods where several SOM layers of variable sizes are used to choose the training data. In [12], Wells, Grimson et.al proposed an Expectation Maximization (EM) algorithm to estimate the bias field for correcting the MRI image with intensity inhomogeneity. The Fig 1: represents the brain with tumor and brain without tumor.

Brain with tumor Brain without tumor

Fig 1: Brain with tumor and without tumor

In [6], a segmentation algorithm is used for brain MRI images using K-means clustering algorithm followed by morphological filtering which avoids the non-clustered regions that can be formed after segmentation of the brain MRI image for detection of tumor location. In [7], the brain image is processed, filtered, skull stripped and segmented. These steps are followed by morphological operation of erosion algorithm to detect the tumor. Then the tumor area is calculated and tumor location is exactly identified.

3. PROPOSED WORK

Several techniques are done in a sequential manner for detecting the tumor. In biopsy process, pathologist takes a specimen of brain cells or brain tumor of the affected human to find the presence of abnormalities from normal human brain. If abnormality is found, it will be referred to an expert doctor. When doctors go for surgery they must know the exact location of tumor.

The paper presents the method based on the location arrangement of each brain component tissue from center of the exact MRI brain image i.e. the spatial arrangement of the brain tissues. Important parts of the brain such as the skull, the grey matter and white matter along with the tumor possess different properties. The Fig 2: represents the flowchart for the proposed algorithm.

The brain MRI images that are undergone a deep biopsy analysis will be given to this computer aided adaptive system for further segmentation. For biopsy a sample tissue of brain that seems to be abnormal will be suggested for test. This is conducted to confirm whether the abnormality is a lesion or a tumor or a mass. The input image will be preprocessed where the halftone image will be converted into grayscale image. After converting to grayscale image the darkest portion will appear in black shade due to total absence of transmitted or reflected light. The lightest portion will appear in white shade due to presence of transmitted or reflected light at all visible wavelengths. The gray scaled image is then vector quantized. In this step a training sequence is chosen as per the [x,y] coordinates of the image pixels. Generate the initial codebook of required size. Compute the transpose of the matrices generated in codebook. Take the mean of the transpose matrix. Compute the transpose of mean matrix. Then codevectors are generated for codebook which is utilized for final step of quantization.

Next step is to binarization of the image. An adaptive binarization technique is used where the vector quantized image is converted to binary image. This step facilitates to compensate the degradation of image causing due to uneven illumination, image contrast variation, smear etc. Then calculate the center of the image to find nearest component that can be recognized as tumor component and demark it. A set of morphological operations are applied on various brain parts based on shape. In morphological operation the value of pixels in the input and output images are compared to get the exact shapes of required parts. Similarly extract

the tumor component, gray matter and white matter and demark it. Then calculate the tumor area according to the proposed system and using manual segmentation. Then compare the obtained values to determine the accuracy.

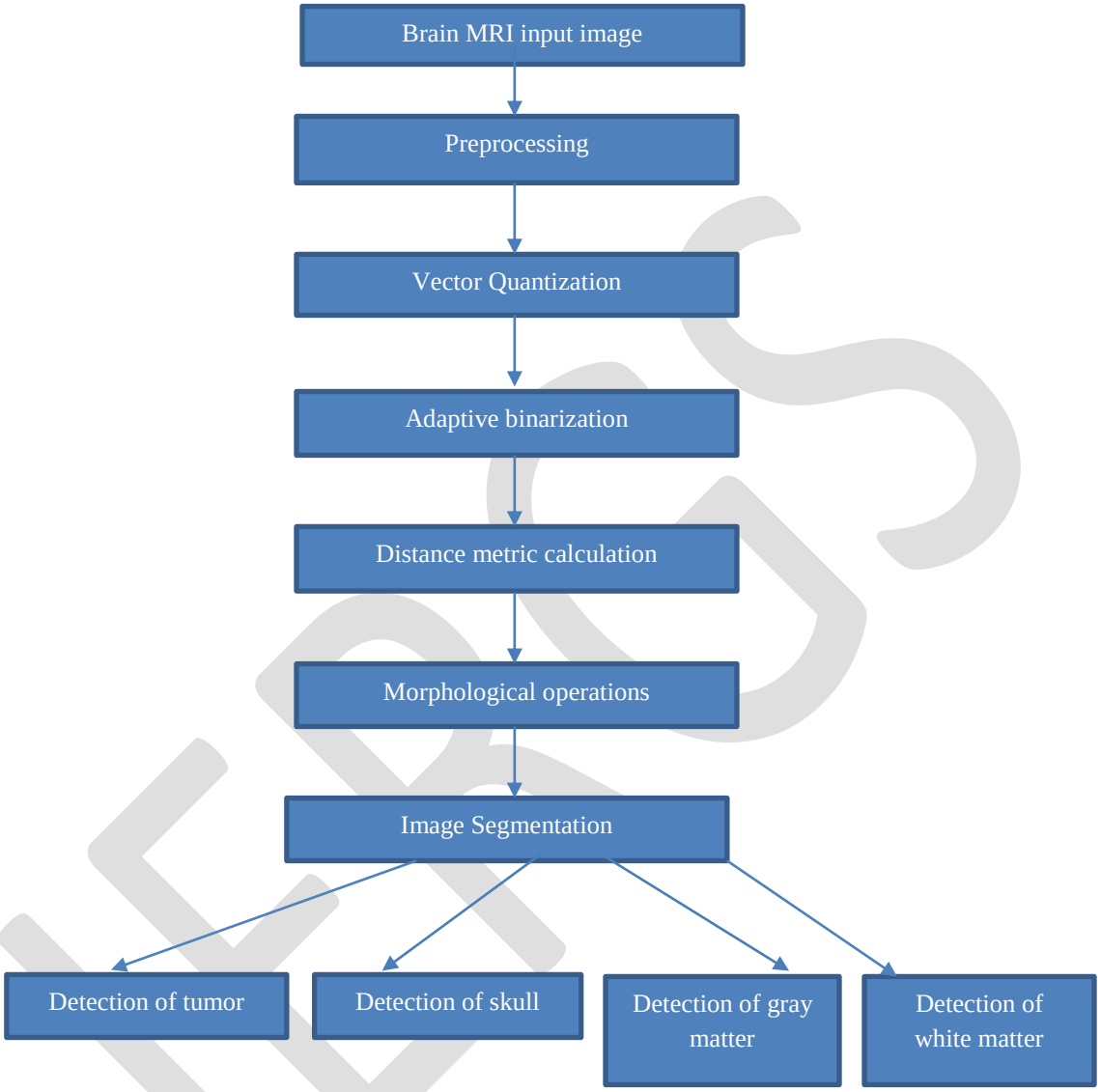


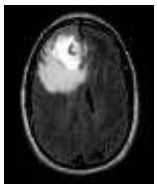
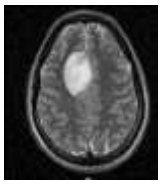
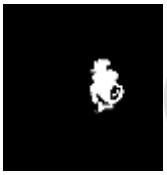
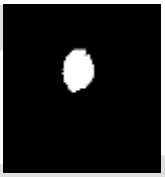
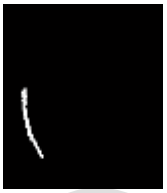
Fig 2: The proposed solution

4. EXPERIMENTAL RESULTS

In this section human brain MRI images obtained from the database are used to demonstrate the effectiveness of the proposed segmentation method. The MRI image can be segmented into tumor component, skull component, gray matter and white matter. The segmented components can be demarked using various morphological operations. It is observable from the experimental result that the proposed work outperforms the existing manual segmentation results.

The Table 1: represents the output of the proposed work. Here the first row represents brain with tumor, second row represents tumor component of the brain image, third row represents skull components of the brain image, fourth row represents the gray matter of the brain image and the last row represents the white matter of the brain image.

Table 1: Experimental results

Brain Images					
Tumor					
Skull					
Gray matter					
White matter					

5. SUMMARY AND FURTHER DISCUSSIONS

The segmentation of the brain MRI image into different components is given as the steps for identifying different components in brain. It will be beneficiary in planning for the surgical and treatment of brain tumor. The proposed system helps in the identification of tumor from other important brain components. It's a computer-aided system for segmentation of brain components that helps to differentiate the tumor part from other brain tissues. The experimental results evaluated according proposed algorithm and manual segmentation method proves that proposed algorithm provides more accurate result than manual segmentation.

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