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K-Means Clustering based Brain Tumor Detection and Area Calculation in MRI With Graphical user Interface

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Abstract*—Magnetic resonance imaging (MRI) is emerging as one of the most clinically applicable imaging modality in the present times. Since its introduction, MRI has been extensively used to construct the cross sectional images of various internal body structures and organs by making use of radio waves and strong magnets. MRI has been extensively used in the detection and diagnosis of tumors and lesions especially in the brain. Tumor is an uncontrolled and unregulated growth of the tissues in any part of the body. Brain tumor is one of the most deadly and life threatening tumors with the researchers in the field calling for better methods and techniques for its early detection so that diagnosis can be made earlier which will eventually lead to better treatment of brain tumors. Computer aided image processing of the MRI images is one of the most important steps towards the reconstruction of the organs of interest. Over the years the application of image processing techniques has rapidly increased in the medical image analysis. Although we have managed to capture and store images digitally still the detail interpretation of medical images is time consuming. Interpretation becomes more difficult near the regions of abnormal shape and color thus needing better image segmentation methods for better tumor detection. Image segmentation is a key step in brain tumor detection. The segmentation of brain image is of utter importance in clinical diagnosis of brain tumor. Due to high noise presence and in homogeneity in brain images the accurate segmentation of brain images is highly difficult but at the same time highly essential in the tumor diagnosis. In this paper we will discuss a method of image segmentation of tumors which is highly accurate and reproducible than the conventional manual segmentation. This method also reduces the image analysis time and extracts the tumor from the MR image such that its exact shape and position can be determined. We can also determine the tumor stage and display that based on the area calculation from the cluster. Such a method if implemented and used will lessen the burden on the radiologists and physicians working in this field and will result in better detection and diagnosis of brain tumors. The graphical user face has been developed in such a way that it is very user friendly and provides with a variety of tumor details.

Keywords*— *Detection; Magnetic Resonance Imaging (MRI); Braintumor; K-means;Image segmentation; Thresholding.

I. INTRODUCTION

Since its invention in 1970, Magnetic resonance imaging (MRI) has turned into a standard clinical medical imaging modality. MRI uses high magnetic fields and short duration radio pulses to image the internal tissues and organs of the body. MRI is relatively a safer imaging modality as compared to other well-known imaging modalities like Computed Tomography (CT) as it doesn't make use of the ionizing rays and thus can be used as often as needed during the treatment. MRI as a tomographic imaging technique is based on the principle of Nuclear Magnetic Resonance (NMR). MRI has been extensively used to image the brain for the detection and diagnosis of brain tumors. In general clinical practices, brain anatomy can be imaged through MRI scan and CT scan. MRI is becoming a choice of brain imaging modality for detection of brain tumors for physicians and radiologist working in the field as it doesn't make use of ionizing X-rays for diagnosis as used in CT thus eliminating the side effects caused to the human body by X-rays [1].

In tumors, abnormal cell growth is witnessed in the affected region of the body. In brain tumor unregulated cell growth occurs within the brain [2]. Tumors can be broadly classified into two types namely, malignant tumors and benign tumors, the former is a spreading tumor while as latter one is limited to a specific part and can be removed. Brain tumors are one of the most dangerous cancers which can be either malignant or benign and can lead to death therefore making the detection of brain tumor a prerequisite for better diagnosis and treatment options. With MRI being highly used imaging modality in brain tumor detection. MRI over the years has proven to be a highly clinical technique for abnormal cell and tissue growth [3]. Brain tumor detection and segmentation in MRI is of utter importance in medical diagnosis as it can equip the

clinicians with the information associated with the anatomical structures including the tumorous tissues, this information is quite necessary for the treatment regimen and post diagnosis patient follow up [4].

Segmentation of brain tumor is also of high importance in general modeling of the brain and the pathological brain atlases construction.Although we have achieved many feats in the field of medical imaging, highly accurate segmentation and characterization of tumor abnormalities has continued to be a challenging task for us. The task is mostly made challenging due to the variety in locations, shapes and image intensities of various tumor types. Tumors present can also lead to the deformation of surrounding organs and tissue spaces and may result in necrosis which can eventually lead to the image density change around the tumor [5].

Despite numerous efforts and promising results in the medical imaging community, accurate and reproducible segmentation and characterization of abnormalities are still a challenging and difficult task because of the variety of the possible shapes, locations and image intensities of various types of tumors. Some of them may also deform the surrounding structures or may be associated to edema or necrosis that change the image intensity around the tumor. Existing methods leave significant room for increased automation, applicability and accuracy.

II. EXISTING IMAGE SEGMENTATION TECHNIQUES

The methods that find their applications in the present imaging and clinical practices are mainly based on threshold and region growing techniques. The threshold methods have been very successful but have had a major drawback as the method is said to be ignoring the spatial characteristics. Ignoring the spatial features with respect to the patient suspecting of having a malignant tumor is something that clinicians and radiologists disapprove of, as they are of the opinion that the spatial characteristics of the malignant tumor are important for the tumor detection [6]. In the threshold based segmentation methods which work on the threshold techniques, the image is assigned only two values, namely, black and white while in the case of bit map, image consists of 0 to 255 gray scale values which mainly cause tumor cells to go unnoticed [7]. Techniques involving region growing based segmentation methods require higher degree of user interaction for the seed selection. Seed can be defined as the center of the tumor cells which causes the intensity in the homogeneity problem. For better clarity, output of the threshold method is shown in Fig. 1 and Fig.2.

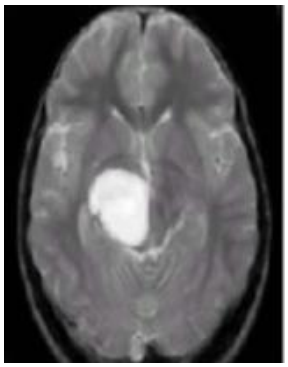

Fig.1. Input image for Thresholding

Fig.2.Output image after Thresholding

Image shown in Fig. 1 is the MR image which will serve as the input image for thresholding. Although even in MR image we can detect the tumor area but the detection is not sufficient enough to make a tumor diagnosis. For better diagnosis, thresholding method is applied on the image. The image in Fig. 2 is the image on which thresholding has been applied. It is a representation of only two values, 1 for white and 0 for black. The background is assigned with the value 0 and the objects get the binary value 1. The resultant image even after the thresholding is not clear enough to make a tumor diagnosis as we are unable to extract tumor information from the image thereby proving out to be a major disadvantage of the existing systems working on threshold based methods. To remove several of such drawbacks from the existing systems we are proposing a method of image segmentation which will aid the clinicians in better tumor detection and diagnosis.

III. K-MEANS CLUSTERING BASED IMAGE SEGMENTATION

In the proposed technique, filtering of the image is done using various filters after which segmentation is carried out by the usage of advanced K-means algorithm. For feature extraction mainly thresholding methods are used. The shape and position of the tumor in the MR image is calculated by using edge detection method. Over the years different types of algorithms have been employed in the MR image analysis but most of these algorithms are not very good for all the MR images. The proposed system manages to remove several of the glitches of the existing algorithms.

During preprocessing, the image is converted from RGB scale to grayscale. Different types of filtering is done on the image for the noise reduction, artifact removal and sharpening of edges in this step. Median filtering is one of commonly carried out filtering in the preprocessing to remove the salt and pepper noise [8]. Median noise is nothing but the noise generated in the image due to the corruption of image pixels thus appearing as white and black dots in the image [9]. For slight insight into the system, we have deliberately introduced the salt and pepper noise and later removed it by median filtering to demonstrate the noise removal phenomenon. Filtering in

the proposed method is done keeping in mind the detection and segmentation of tumor cells.

The technique employs K-means clustering method for the segmentation process. K-means is counted among the best of unsupervised learning algorithms for clusters. Initially, the image clustering is done on the image. Clustering involves the grouping of pixels according to some characteristic [10]. For incorporating K-means algorithm we need to define the number of clusters (k). Once the clusters have been defined then k cluster centers are assigned randomly. Following which distance from pixel to each cluster center is calculated. Every single pixel in the image is compared to the k cluster centers using the distance formula (Simple Euclidean Function). After this a specific pixel is moved to a particular cluster having the shortest distance among all [11]. This results in the re-estimation of the cluster center or centroid. Each pixel is compared to all the centroids until the center converges. Fig. 3 shows the detailed flowchart of the k-means clustering.

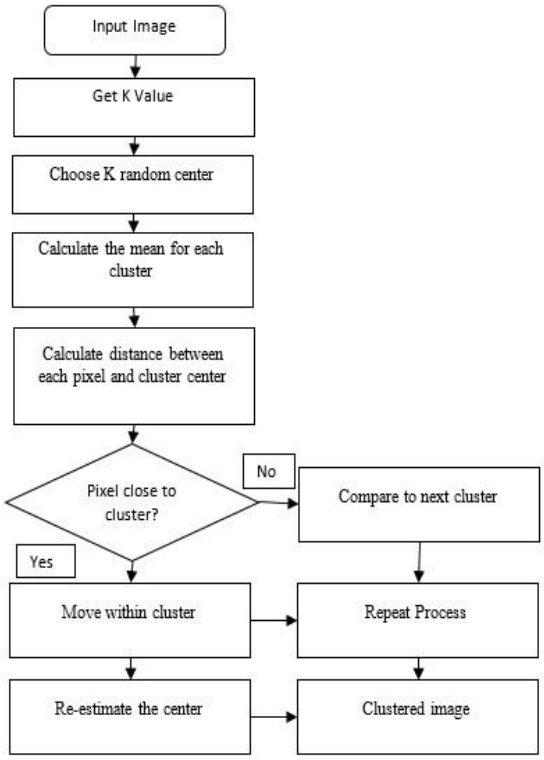

Fig. 3. K-means clustering flowchart

IV. GRAPHICAL USER INTERFACE (GUI) DEVELOPMENT

Graphical user interface is a platform which allows the human to interact with the computer and electronic devices [12]. The graphical user interface of the system has been developed for a user friendly experience. The interface design has been kept simple which makes it very easy to use and operate with.

A. Basic Graphical User Interface

This is the basic user interface of the system through which a user-system interaction is possible. As shown in Fig. 4, it consists of various buttons that have a specifically assigned functionality. "Browse" button can be pressed to browse the database, while as "show" button results in the display of the selected image. "K-means" button on pressing displays the image clusters after the application of k- means algorithm. Similarly, "area" button is used to calculate and then display tumor area from the image. "Stage'' button on the GUI is used to display the brain tumor stage.

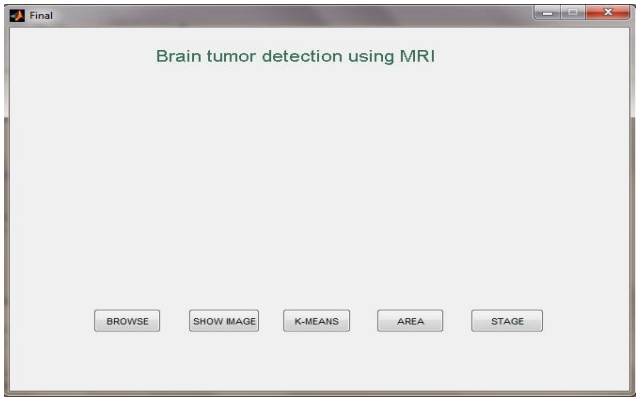

Fig. 4. Basic Graphical User Interface

B.User Interface with Details

The buttons on the GUI are to be pressed according to the sequence shown in the GUI. Once the image has been browsed, the user will be allowed to display and process the image for stage and area calculation of the tumor.

C.User interface on pressing browse button

"Browse" button allows the user to select an image from different supported formats like .jpg, .jpeg, .bmp, .pngetc. from the database. On pressing it the window in Fig. 5 is displayed which allows the selection of the specific image.

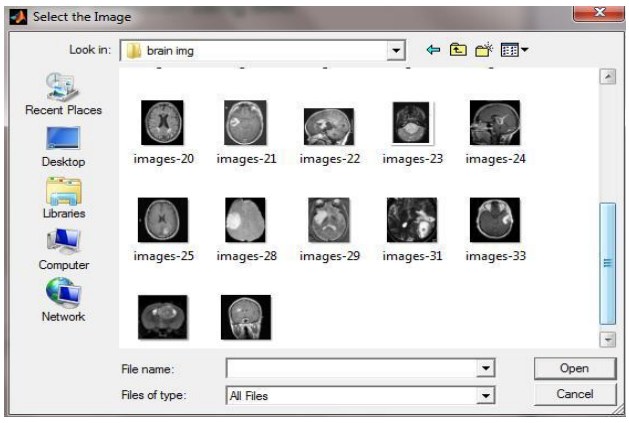

Fig. 5. GUI on pressing browse

D.User Interface on Pressing Show Image Button

Once the image has been selected, the same can be displayed by pressing the "show image"button. The same image is used for further processing. After browsing the database the user needs to press the "show image" button. This button displays an image selected from the database on GUI. This image is used for further processing. The GUI changes to Fig. 6 after pressing "show image" button.

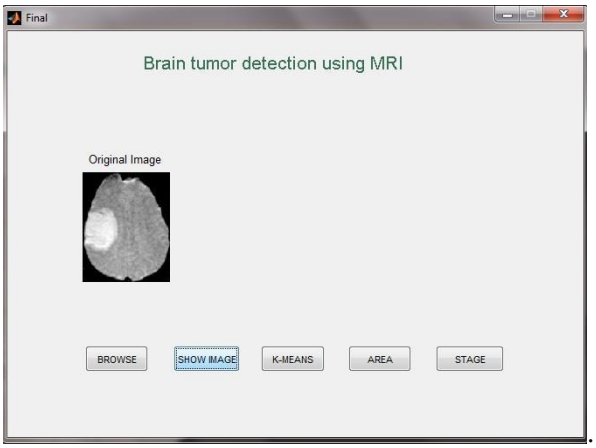

Fig. 6. GUI on pressing show image

E. User Interface on pressing K-means button

Once the image has been displayed the user has to extract the tumor information from the image. This option offers to display the various clusters which are formed after K-means clustering. Once this has been done, the tumor stage can be calculated after this.GUI on pressing "k-means" button is shown in the following Fig. 7.

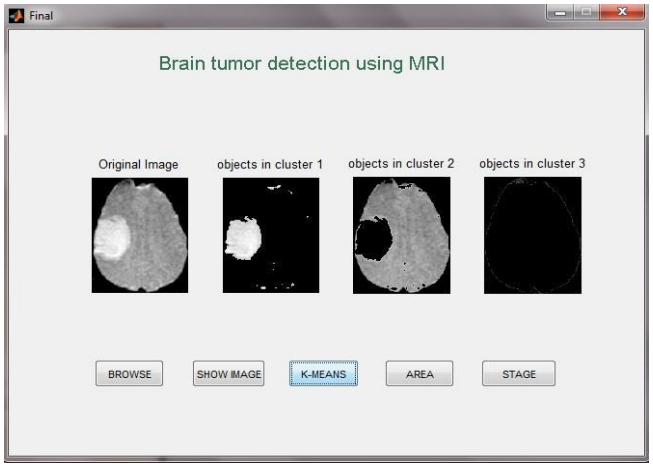

Fig. 7. GUI after pressing K-means

F. User Interface on pressing area button

K-means clustering is an essential step in the tumor area calculation. The area can be displayed in terms of their infected percentages. This infected percentage value serves as the criteria for tumor stage calculation. It is a vital step as this alone will be used for tumor stage calculation. The GUI after pressing "area" is shown in the following Fig. 8.

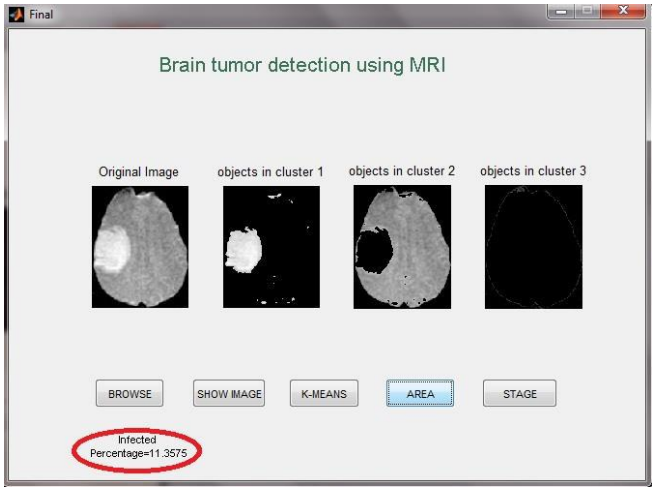

Fig. 8. GUI on pressing area

G.User Interface on pressing stage button

This is the last step in the process of tumor detection. After the area calculation has been done, by pressing this button on GUI, the brain tumor stage gets displayed. There are usually three standard tumor stages and they can be displayed on the basis of area that has been calculated. If no tumor is detected then healthy brain will be displayed. The following Fig. 9 shows the GUI on pressing "stage" button.

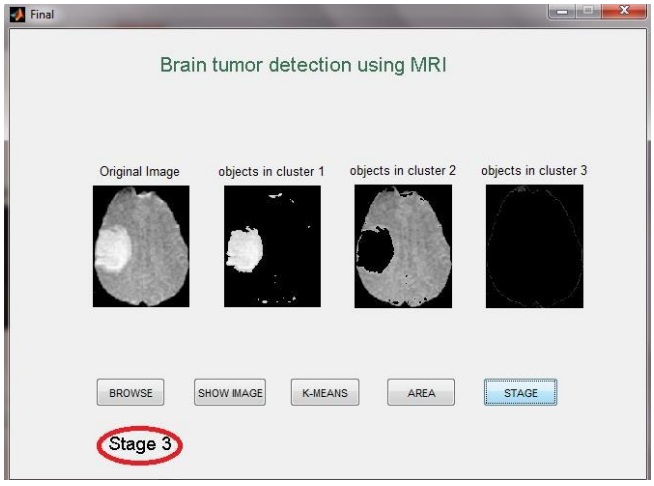

Fig. 9. GUI on pressing stage

V. CONCLUSION

Brain tumor is an abnormal growth of body cells and medical imaging plays a very key role in the brain tumor diagnosis. We saw how MRI over the years has turned into a vital modality for imaging brain tumors and how image segmentation plays a vital role in the tumor detection and diagnosis in MR Images. The tumor detection and its significance was discussed with respect to the clinical treatment of the condition and various challenges that the

researchers face in the brain tumor imaging. We talked aboutvarious Image segmentation methods, a brief outlook was given about the existing image segmentation methods and the shortcomings they face. K-means clustering was developed for the system and it was seen that the reconstructed image provided much better degree of tumor detection. Filtering techniques were applied on the image for noise reduction and better tumor extraction. The user friendly GUI was also developed for the system for better user experience while diagnosing and detecting the brain tumor. The developed system was seen to determine the tumor area and then by calculating the infected area percentage could display the present stage of the tumor. Although, brain tumor area and various other characteristic information could be retrieved from the MR image but still this system was unable to predict the nature of the tumor, whether it is a benign or a malignant tumor. This is one of the limitations of the system and its removal we leave for the future studies.

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