IDENTIFICATION AND DOSE QUANTIFICATION OF THE HUMAN BRAIN TUMOR

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Abstract: Brain tumor segmentation is one of the computationally challenging tasks in the medical area because the target segmentation consists on the extraction process of tumor regions from images. Medical experts as per their experience do this manually which is not always obvious due to the similarity between tumor and normal tissues and the high diversity in tumors appearance. In view of this, automating medical image segmentation remains a real challenge. In this project, the work is focused on support vector machine learning method based segmentation of Magnetic Resonance Brain Images (MRI). The fundamental conceptual framework is to consider this problem as a classification problem where the aim is to distinguish between normal and abnormal pixels on the basis of several features, namely intensities and texture. More precisely, we propose to use Support Vector Machine (SVM) which is within popular and well motivating classification methods. The project also implements dose quantification which suggests the amount of radiation in the therapy required. The project has been carried on data set representing different tumor shapes, locations, sizes and image intensities has been collected from medical physics section of Radiological Physics Advisory Division, BARC.

***Keyword* – Brain Tumor Classification, Tumor Segmentation, Dosage Calculation, Support Vector Machine (SVM).**

I. INTRODUCTION

A brain tumor is a collection, or mass, of abnormal cells in human brain. Symptoms of brain tumors depend on the location and size of the tumor. They can lead to death if they are not detected early and accurately. While brain tumors are not very common, they are one of the most lethal cancers. Depending on their initial origin, brain tumors can be considered as either primary brain tumors or metastatic brain tumors. Medical Imaging techniques such as Computed Tomography (CT), Magnetic Resonance Imaging (MRI) are used to provide valuable information about shape, size, location and metabolism of brain tumors assisting in diagnosis. However, since manual segmentation is a very time consuming procedure, development of robust automatic segmentation methods, to provide efficient and objective segmentation, became an interesting and popular research area in recent years. So, we are developing a system which will overcome these limitations.

In this work, we present an automatic brain tumor segmentation technique based on support vector machine. Images are collected from medical physics section of Radiological Physics Advisory Division, BARC.

II. AIM AND OBJECTIVE

Aim:

- Reducing the time required in analyzing the MRI images for a potential tumor region.
- Increasing the accuracy of the detection.
- Prove an aid for the doctor to suggest an appropriate dosage

Objectives:

- Design a module to automatically segment the tumor region (if any) from the entire MRI scan.
- Classify that tumor region either Malignant or Benign using Support Vector Machine (SVM).
- Build a dosage entire to compute the dosage required based on the tumor region.

III. LITERATURE REVIEW

R.Muthukrishnan et.al, [1] Proposed brain tumor detection in which Segmentation separates an image into its component regions or objects. Image segmentation it needs to segment the object from the background to read the image properly and classify the content of the image carefully. In this framework, edge detection was an important tool for image segmentation. In this paper their effort was made to study the performance of most commonly used edge detection techniques for image segmentation and also the comparison of these techniques was carried out with an experiment.

P.NandaGopal et.al, [2] in their paper they presented a combination of wavelet statistical features (WST) and co-occurrence wavelet texture feature (WCT) obtained from two level dis- tinct wavelet transform was used for the organization of abnormal brain matters into benign and malignant. The planned system was consists of four stages: segmentation of region of interest, discrete wavelet disintegration, feature abstraction, feature selection, organization and evaluation. The support vector machine was employed for brain tumor segmentation. A grouping of WST and WCT was used for feature extraction of tumor region extracted from two level discrete wavelet transform. Genetic algorithm was used to select the optimal texture features from the set of mined features. The probabilistic neural network was used to classify abnormal brain tissue in to benign and malignant and the performance evaluation was done by comparing the classification result of PNN with other neural network classifier. The classification accuracy of the proposed system is 97.5 percent.

A.Krizhevsky et al, [3] have introduced a new algorithm for detecting and grouping brain tumors. In this method, using techniques on computer MRI images of patients who suffer from brain cancer, tumor blocks are detected and then these blocks are classified using Convolution Neural Networks (CNN).

IV. PROPOSED METHODOLOGY

The work presented in this paper focuses on developing a segmentation and classification system which can be explained by following State Transition Diagram.

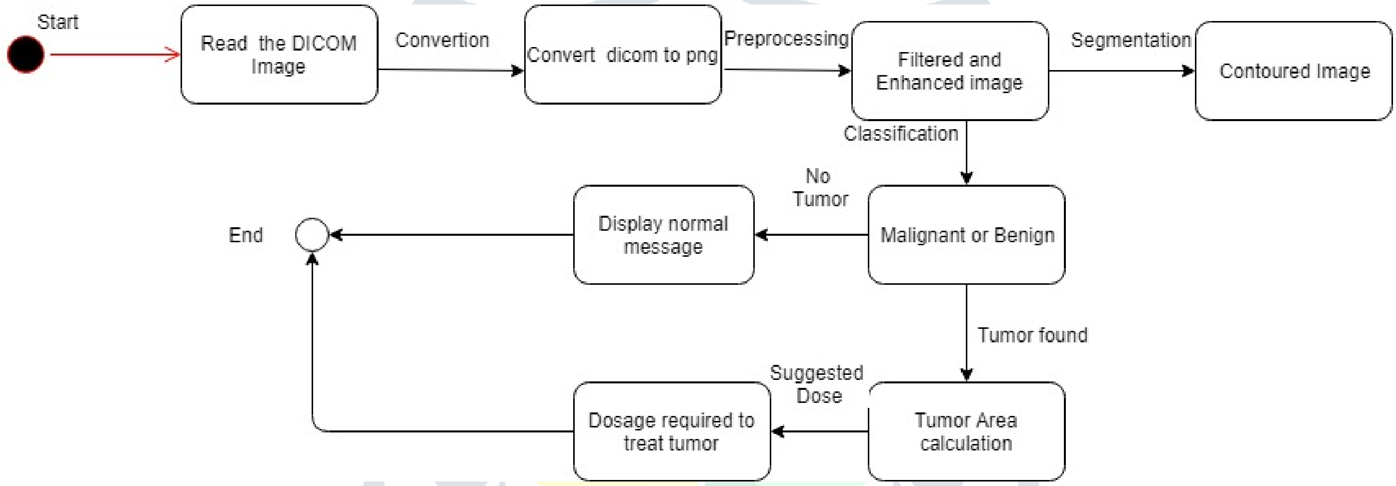

Figure 1: State Transition Diagram

Implementation and coding phase for the application is done using the following steps:

1. Read the brain MR image which is in dicom format and convert it into png format.
2. Image pre-processing using median filter.
3. Otsu Thresholding
4. Segmentation of the brain MR image.
5. Tumor extraction.
6. Classification and area calculation of the tumor.
7. Dosage Suggestion and display result.

The detail description of each step is as follows:

1. Read the Brain MR image

In this step the brain MR image is read. The format of the image is in dicom format. The .dcm image is converted into the .png format. Thus the converted image format is small in size as the unnecessary meta data of the patient is removed and thus further processing of the image can be carried out faster and efficiently.

2. Image processing using median filter

In this step the image pre processing is carried out. The median filter is used to remove the salt and pepper noise from the image. Salt and pepper noise is characterized by black and white spots randomly distributed in an image. The median filter also pre- serves edge details of the image while removing noise. Thus this helps to effectively carry out the segmentation of brain MR image.

3. Otsu Thresholding

In this step the removal of several of non brain tissues is carried out.

- (a) Conversion to binary image: The input image is converted to binary image with Otsu's thresholding. The algorithm considers the image as two classes of pixels, foreground pixels and background pixels. Optimum threshold is obtained which separates the two classes so that their intra-class variance is minimal and inter- class variance is maximal.
- (b) Creation of mask: Brain is the largest connected component. This component is extracted from the binary image. Dilation and erosion operations are performed to preserve the minute features of the brain in the resultant image. By filling the holes, the brain becomes a complete connected component.
- (c) Superimposition: The final brain image is obtained by superimposing the mask on the input image.

4. Segmentation of the brain MR image

In this step the various parts within the brain are segmented using watershed image segmentation technique. To perform watershed segmentation, a grayscale image is considered. The grayscale values of the image represent the peaks and valleys of the topographic terrain of the image. The lowest valley in an object is the absolute minimum. The highest grayscale value corresponds to the highest point in the terrain. The watershed segmentation can be explained as follows: all the points in a region where if a drop of water was placed will settle to the absolute minimum are known as the catchment basin of that minimum or watershed. If water is supplied at a uniform rate from the absolute minimum in an object, as water fills up the object, at some point water will over flow into other objects. Dams are constructed to stop water from overflowing into other objects/regions. These dams are the watershed segmentation lines. The watershed segmentation lines are edges that separate one object from another. Thus the region of interest which is tumor can be easily extracted and further processing can be carried out.

5. Tumor extraction

The segmented brain MR image is further processed using labeling algorithm. The various parts of the image are labeled using the labeling algorithm and the tumor region is extracted from the segmented image with the help of label corresponding to the tumor.

6. Classification and area calculation of the tumor

The extracted tumor part is feeded to the SVM machine learning algorithm to classify it as the cancerous of non-cancerous tumor. The various features used by the SVM to classify the tumor are as follows:
(a) LBP Energy (Local Binary Pattern)
(b) Contrast
(c) Dissimilarity
(d) Homogeneity
(e) Energy
(f) Correlation
(g)ASM

The area of the tumor part is calculated so as to suggest the dosage. The area of the tumor is calculated in terms of number of pixels constituted inside the tumor. The area calculation is carried out with the help of numpy library in python.

7. Dosage Suggestion and display result

Firstly, the dose calculation has to be fast such that the treatment planning process can be completed in clinically acceptable time frames, and secondly, the result of the dose calculation has to be sufficiently accurate so that the establishment of correlations between delivered dose and clinical effects remains reliable and meaningful. The conflict between "high speed" and "high accuracy" is one of the crucial challenges for the development of modern dose calculation algorithms.
In this project, the model parameters were commissioned for the 6-15MV beam of a Varian 21EX linac. The dose distributions can be calculated assuming a semi-infinite flat phantom. We define the coordinate system such that the origin is at the surface, the z-axis points into the phantom, and the x–y plane coincides with the surface. By generalizing the equation given in Ceberg et al (1996) to a non-uniform incident fluence profile, the dose at (x, y) and depth z can be given by:

$$\mathbf{D(x, y, z) = MCfSc\ (CS)\ A\ (z) \iint (x', y')\ k(r, z)\ dx\ dy\ -\ (1)}$$

Here r = (x'− x) + (y'− y) is a planar distance between the beam incident point (x', y') and the calculation point(x , y). M is the number of pixel units, Cf is the calibration factor (for this project Cf = 1 cGy MU at the depth of the maximum dose, dmax, for a 10 × 10 cm2 open field and 100 cm SAD), and Sc(CS) is the collimator scatter factor. Using the attenuation coefficient and beam-hardening coefficient, the transmission of a photon beam through a water of thickness z is represented by:

$$\mathbf{A\ (z) = Ao * e\text{^}\ (-\mu z\ (1 - \eta z))}$$

Here, a constant, Ao, is obtained so that the dose at z = dmax.

V. RESULTS AND DISCUSSION

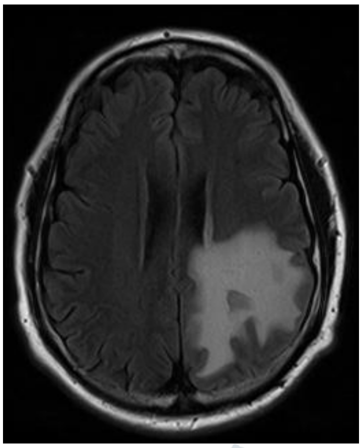

Fig 2. Original MR Image

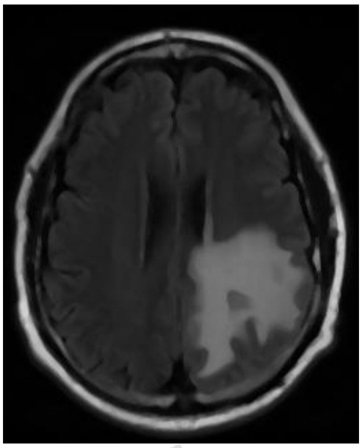

Fig 3. Image after applying Median Filter

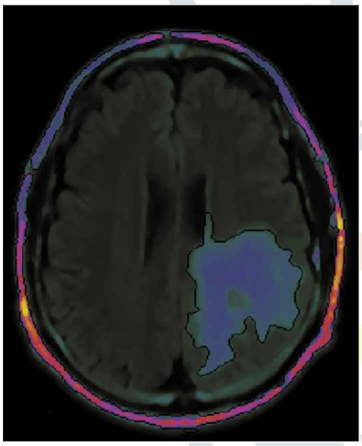

Fig 4. Image after applying watershed segmentation

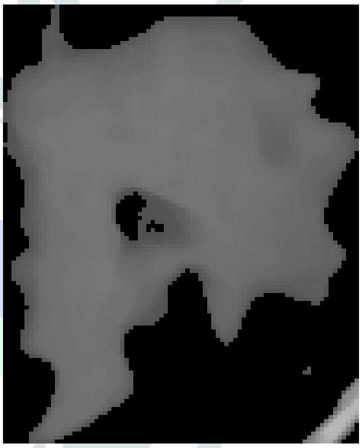

Fig 5. Extracted Tumor part

1. Classification Result

Malignant

2. Dosage Computation

DOSE = 51.96544339972003 Gy

3. GUI Screenshot

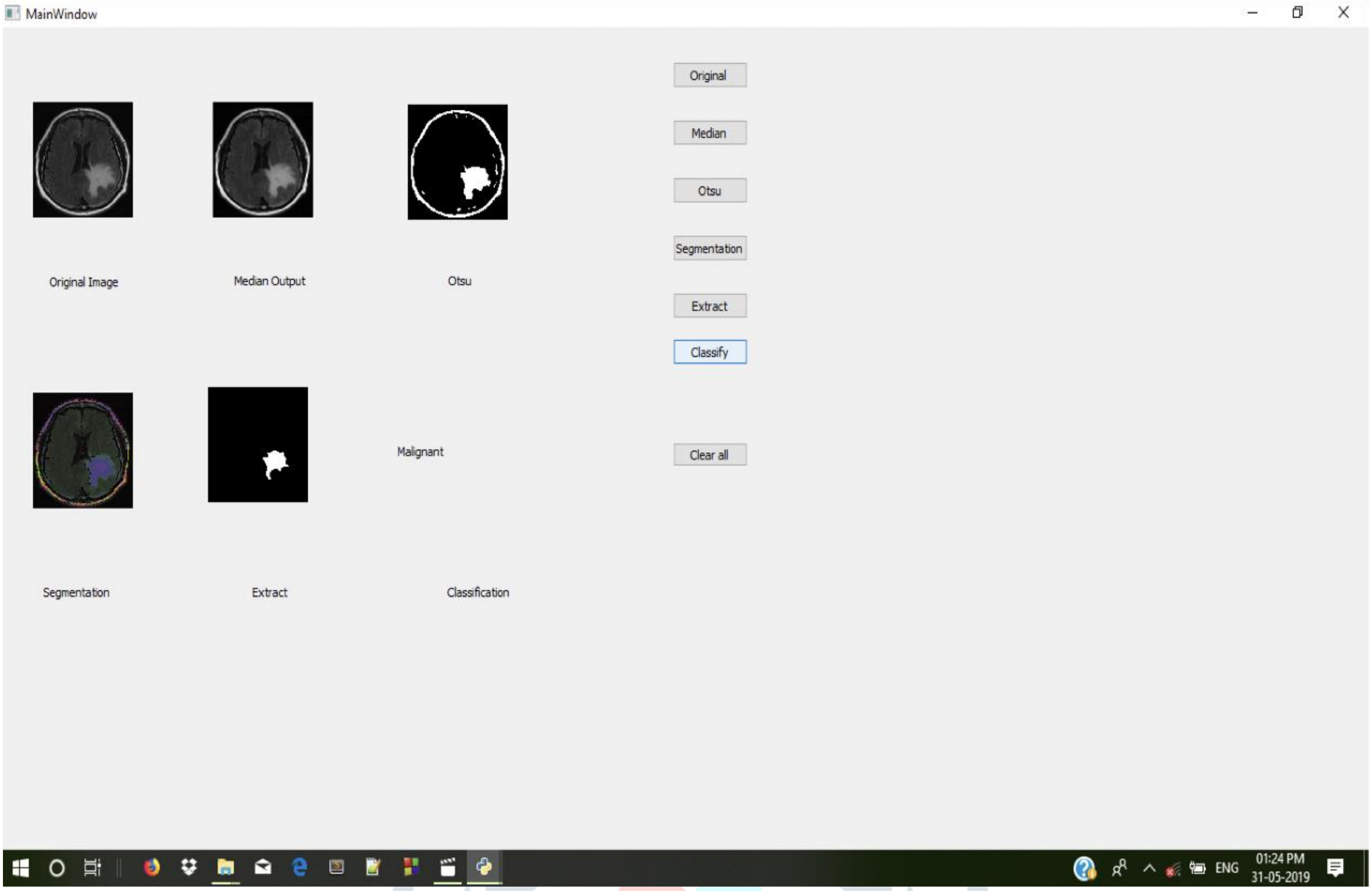

Fig 6. GUI Screenshot

Patient ID	Image Type	Pixel Count(Tumor Region)	Energy(Feature Value)	Tumor Classification	Dose Value (Gy)
1	Flair	5440	0.3416	Malignant	55.19654
2	Flair	1251	0.3552	Malignant	40.96509
3	Flair	4384	0.3750	Malignant	38.54329
4	Flair	5738	0.4440	Malignant	51.53438
5	Flair	1337	0.4354	Malignant	31.8396
6	Flair	5804	0.4649	Benign	36.2066
7	Flair	1884	0.2096	Benign	25.0811
8	Flair	1727	0.3462	Benign	26.8957
9	Flair	6596	0.4337	Benign	29.72152
10	Flair	2420	0.3838	Benign	30.7839

Table 1: Result Tabulation

Hence using segmentation technique and support vector machine the tumor can be classified either as malignant or benign and accordingly using pencil beam algorithm the dosage value can be computed.

IV. Conclusion

In this project implementation of brain tumor segmentation and classifier is carried out while trying to optimize the waiting time. The optimization of waiting time is achieved by integrating the different systems currently in use into a single system. Apart from segmentation and classification which aim to optimize the waiting time, the implemented system aims to suggest dose of radiation therapy to cure the identified tumor. According to the results the system worked successfully for different images and also suggested the dose accordingly. Creating a 3D model of human brain can help in visualizing and studying tumor area in greater depth is a scope for future work and development.

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