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Oral Cancer Detection by Image Processing Using MATLAB

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ABSTRACT

This paper suggests an automated process for the identification of oral cancer. And also very tiny tumors in computed tomography (CT scan) can be detected very easily by this proposed algorithm. Detection of oral cancer is a challenge in medical applications due to the structure of the tumor cells. This project presents a segmentation and K-Means clustering algorithm for the segmentation of computed tomography scan (CT scan) to detect the oral cancer. The segmentation output will be used as the basis for the Computer Aided Diagnosis (CAD) program for early detection of oral cancer to boost the patient's chances of survival. Detection and extraction of tumors from CT scan images is performed using code developed in MATLAB.

Keywords: *computed tomography scan (CT scan), Segmentation, Computer Aided Diagnosis (CAD), MATLAB.*

1. INTRODUCTION

Cancer happens when cells in the body change and develop out of control. Your body consists of tiny building blocks called cells. Normal cells expand when your body needs them and die when your body no longer needs them. Cancer is made up of abnormal cells that expand even though your body does not need them. In most types of cancer, abnormal cells develop to form a lump or mass called a tumor.

Oral cancer is a cancer that occurs in the mouth or throat. Oral cancer is fairly common and very curable if it is detected and treated early. Oral cancer is usually found by a doctor or dentist at an early stage because the mouth can be easily inspected.

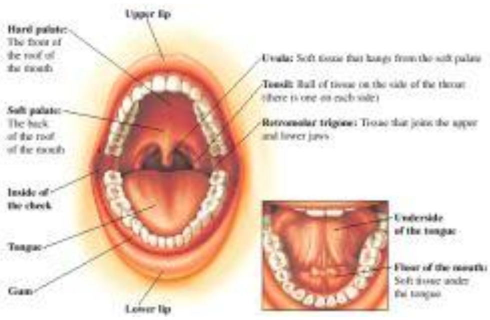

Figure 1: oral cavity

1.1 Considering the mouth and throat

The mouth is also referred to as the oral cavity.

- The lips

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- the padding inside the lips and the cheeks (buccal mucosa)
- the front two-thirds of the tongue (oral tongue)
- the gums and teeth
- the bottom of the mouth (floor)
- the bony top of the mouth (hard palate)
- The area behind the wisdom teeth (retromolar trigone)
- The back of the tongue (base of the tongue), the back of the mouth (soft palate) and the tonsils are not considered part of the oral cavity. Alternatively, they are considered to be part of a region called the throat (oropharynx).

Each part of the mouth has a very important function. The lips, for example, are very important for speaking. The tongue is also very important for communicating and swallowing. The gums help to protect the teeth and keep them healthy. Salivary glands in the mouth produce saliva that keeps the mouth moist and helps digest food. Some details of oral cavity are shown in the Figure 1: oral cavity.

Oral cancers can cause problems with eating and talking, and can sometimes impede normal breathing.

1.2 Types of oral cancer

More than 90% of all oral cavity tumors are squamous cell carcinoma. Squamous cells form the lining of the oral cavity (the mucosa). While cancer develops in the lining of the mouth, it can spread further into the neighbouring tissues of the body.

Verrucous carcinoma is a different type of oral cancer. It is considered a type of squamous cell carcinoma, but this low-grade cancer seldom spreads to distant locations (metastases). This accounts for less than 5% of all diagnosed oral cancers.

Other much less common types of oral cancer include salivary gland tumors, including adenoid cystic carcinoma, adenocarcinoma, and other types of salivary gland cancers.

Factors that increase your risk of developing oral cancer include:

- smoking or using other types of tobacco
- drinking alcohol by people who drink and smoke are at a far higher risk compared to the general population
- human papillomavirus (HPV) HPV infection is a virus that causes genital warts.

Just one in eight (12.5%) cases affects people younger than 50 years of age.

Among younger adults, oral cancer can occur. HPV infection is believed to be associated with the majority of cases occurring in younger people.

Oral cancer is also more common in men than in women. This may be because, on average, men tend to drink more alcohol than women do.

Treatment of oral cancer There are three main treatment options for oral cancer:

- **Surgery** in which cancer cells are surgically removed along with a tiny bit of the surrounding normal tissue or cells to ensure the cancer is completely removed
- **Radiotherapy** in which high-energyx-rays are used to kill cancer cells

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- **Chemotherapy** in which potent drugs are used to kill cancer cells

These procedures are often used in conjunction. Of example, surgery may be accompanied by a course of radiotherapy to help prevent cancer from returning.

As well as trying to cure cancer, therapy will focus on important functions of the body, such as breathing, talking and eating. A high priority will also be given to preserving the appearance of your mouth.

It can affect the appearance of your mouth and make this difficult to talk and swallow (dysphagia).

Dysphagia could be a potentially serious problem. When small pieces of food penetrate your airways and remain in your lungs, it could cause a chest infection, known as aspiration pneumonia.

When you drink as many as 14 units a week, it's best to spread it evenly over three or more days.

For cases where the cancer is bigger, there is still a good chance of a cure, so surgery should be accompanied by radiotherapy or a combination of radiotherapy and chemotherapy to give you the best chance.

Advances in surgery, radiotherapy and chemotherapy have resulted in much higher cure levels.

Generally, about 60 per cent of people with oral cancer will live at least five years after their diagnosis, and many will live much longer without the cancer returning.

2. RELATED WORK

Dr. P.V. Rama raju et al., proposed an automatic segmentation technique based on convolution neural network, patch, analysing 10*10 kernels using MATLAB. The main use of CNN's their accuracy in image detection problems. Input image is changed into a specific number of patches for easy processing [3]. A. Parent et al., explained a completely revised and updated text, retaining the morphological approach of previous editions, but with additional material on neuroscience, new information on the distribution of neurotransmitters in the brain, and more than 100 new illustrations and several new tables [1]. Dr. P.V. Rama Raju et al., suggested pre-programmed pest identification systems using various image processing techniques. Initially, identifying and capturing the leaf with pest is done and in the subsequent techniques of image processing such as HSI conversion, segmentation, clustering, classifiers etc., are applied. Feature extraction is done on the area of interest of the segments [6]. Dr. P.V. Rama Raju et al., concentrates on detecting nodules, early stages of cancer diseases, appearing in patients' lungs. Most of the nodules can be observed after carefully selection of parameters. The training dataset of CT images are processed in three stages to attain more quality and accuracy in the processed examination [10]. Anam Mustaqeem et al., proposed an efficient algorithm for tumor detection based on segmentation and morphological operators. Firstly, quality of scanned image is enhanced and then morphological operators are applied to detect the tumor in the scanned image [7]. G. Nagaraju et al., proposed an efficient algorithm for tumor detection based on segmentation and morphological operators. Firstly, quality of scanned images is enhanced to remove noise and then morphological operators are applied to detect the tumor in the scanned image [13]. Dr. P.V.Rama Raju et al., proposed an approach of leukemia detection process image is a tool which is used here for understanding the process of entire detection. And this tool has an inbuilt procedure for pre-processing and segmentation [17]. Z. Afrose, deals with the performance study of Median, Relaxed median, Wiener, Centre weighted median and Averaging filters to remove Salt and pepper, Gaussian and Speckle noise in the compound images. This paper proposes relaxed median filter performs better for compound images [12]. Dr. P.V. Rama.Raju et al., proposed system includes segmentation and K-means clustering for segmenting the computed tomography (CT) images, and probabilistic neural network is used to detect the tumor in the earlier stages [21].

3. THE PROPOSED MODEL

3.1 Image Enhancement

In order to improve the visual effects of the image for image recognition, MR image pre-processing or enhancement is required, which mainly involves grayscale color image, image smoothing and sharpening. Photo smoothing is designed to eliminate noise and improve image quality. The aim of image sharpening is to make the edges of the tumor, the contour lines and the features of the picture clearer. The same method will be applied to the actual target image. Photo filtering is useful for many uses, including smoothing, sharpening, noise reduction, and edge detection. A filter is defined by a kernel, which is a small array applied to each pixel and its neighbors in an image. In most implementations, the centre of the kernel is associated with the current pixel, and there is a square with the odd number 3, 5, 7, etc. of the elements in each dimension. The method used to apply filters to an image is known as convolution and can be applied to either the spatial or the frequency domain.

3.2 K-Means Clustering

The K-means clustering algorithm is widely used for multi-dimensional data segmentation. K-means works by assigning multidimensional vectors to one of the K clusters in which K is assigned a priori. The goal of the algorithm is to minimize the variance of the vectors assigned to each cluster. The algorithm is iterative after each vector is allocated to one of the clusters, the cluster centres are recalculated and the vectors are reassigned using the new cluster centres. K-means clustering is a type of partitioning. K implies partitioning data into mutually exclusive clusters of K, and returns the index of the cluster to which each observation has been assigned. Unlike hierarchical clustering, K-means clustering works on actual observations (rather than a broader collection of dissimilarity measures) and generates a single cluster stage. Distinctions mean that k-means clustering is often more suitable than hierarchical clustering for large amounts of data. K-means views each observation in the data as an entity with a space position. Finds a partition in which objects within each cluster are as close to each other as possible and as far away from objects in other clusters as possible. Each parameter can be selected from five different distance measurements, depending on the type of data used for clustering. That cluster in the partition is identified by its member objects and its centroid or center. The centroid of each cluster is the point at which the sum of distances from all points in the cluster is reduced. K-means calculate cluster centroids differently for each distance factor, in order to minimize the sum with respect to the measure defined. K-means uses an iterative algorithm that minimizes the number of distances from each point to its centroid cluster over all clusters. This algorithm transfers items between clusters until the sum cannot be further reduced. The result is a group of clusters that are as compact and as well-separated as possible. Minimization information can be managed using a variety of optional K-means input parameters, including the initial values of the cluster centroids and the maximum number of iterations.

3.2.1 Algorithm For K-Means Clustering

K-means the algorithm contains

Let X_1......X_N are N data points in the input image, let k be the number of clusters which is given by the user.

Choose $C_1...C_K$ cluster centres.

Distance between each pixel and each cluster centre, which is called as centroid is found.

The distance function is given by j=$|X_i-C_j|$ for i=1…N and for j=1….k, where $|X_i-C_j|$, the absolute difference of the between a data point and the cluster centre indicates the distance of the N data points from their respective cluster centres.

Distribute the data points x among the k clusters using the relation x belongs to c_i if $|x-c^j|<|x-C_j|$ for i=1,2,3…..k, i notequal to j, where denotes the set of data points whose cluster.

Updated cluster centre is given as, C_k=i, for i=1,….,k, where i is the number of objects in the dataset, where k is the number of cluster and C is the centre of cluster.

Repeat from step 5 to step 8 till convergence is met for all data points.

After segmentation and detection of the desired region, there are chances for misclustered regions to occur after the segmentation algorithm, hence morphological filtering is performed for enhancement of the tumor detected portion. Here the structuring element used is disk shaped. Figure 2 represents the flow chart for the K-means clustering.

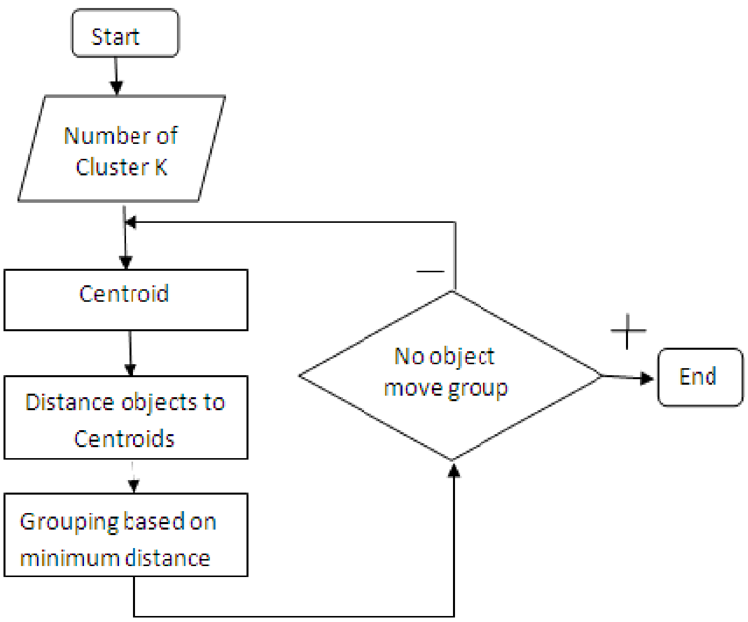

Figure 2: The flow chart for the K-means clustering

3.3 Morphological Segmentation

Morphological operations include filtering the mark map so that the boundary of the designated area either grows (dilation) or shrinks (erosion). Sequences of morphological operations that increase manual segmentation by filling small holes or breaking up inter-regional connections. Thresholding is another filtering tool used to mark pixels whose gray scale values are within the desired range.

Morphological processing is based on pixel sets operations. Binary morphology uses only a fixed membership and is oblivious to the value of a pixel, such as the gray level or color [17]. Morphological image processing is based on the ordering of pixels in an image and is often applied to binary and grayscale images. By means of processes such as erosion, dilation, opening and closing, binary images can be changed to the user specifications [18]. Binary images are picturing whose pixels have only two possible values of color. Usually, they are shown as black and white. Numerically, the values are often 0 for black, and 1 or 255 for white. Binary images are often created by thresholding a gray scale or a color image, in order to separate the object from the background in the picture. The color of the object (usually white) is referred to as the foreground color. The remainder (usually black) is referred to as the background color. But, depending on the picture that is to be a threshold, this polarity may be reversed and, in that case, the object is shown with 0 and the context with a non-zero value [19]. Many morphological operators assume a certain polarity of the binary input image so that the operator will have the opposite effect if we process an image with an inverse polarity. For example, if we add a black text on a white background to the closing operator, the text will be opened.

Morphological segmentation describes the segmentation of the tumor in the throat. The proposed solution uses segmentation mathematical morphology operations. Morphological operations are applied to gray scale images to the section of irregular regions. Erosion and dilation are the two fundamental operations of mathematical morphology. The combination of the two represents the remainder of the operations [20].

3.4 Image Compression

In order to reduce redundant content, image data compression techniques are used to facilitate the storage, transmission and distribution of images (example: JPEG, PING, TIFF and GIF). JPEG offers exceptional quality at high and medium bit rates. Nonetheless, the quality is reasonable at low bit rates (example: below0.25bpp). The new JPEG format includes some resynchronization indicators, but the quality is still reduced when bit errors are found. JPEG has been optimized for natural photos. JPEG2000 is a modern compression format used for still images, intended to resolve the limitations in the existing JPEG standard. The JPEG 2000 format uses wavelet and subband technologies. Some of the markets addressed by the JPEG 2000 standards include publishing, internet, remote sensing, digital photography, e-commerce, mobile and digital libraries. This model provides lossy compression with superior performance at low bit rates and also reduces loss of compression with progressive decoding. Applications such as digital libraries / data bases and medical imaging can benefit from this feature[21]. The specification provides a collection of error-resilient devices to make the bit stream more robust for transmission errors. The regions of interest (ROIs) can be described in this mode. Such ROIs can be encoded and transmitted with better quality than the rest of the file.

4. SIMULATION RESULTS AND ANALYSIS

The simulation results are taken for 5 patients CT scan images. The original CT scan image is converted into a gray scale image and it is given as input to median filter followed by adaptive filter. And then followed by morphological operations erosion and dilation. Then the tumor is extracted from image to calculate the area.

The following are test results of KUDUPUDI BABJI RAO:

By running the code on the CT scan of KUDUPUDI BABJI RAO we get the outputs as the original and gray scale image of CT scan of KUDUPUDI BABJI RAO as shown figure 3(a), the median and adaptive filter outputs as shown in figure 3(b), erosion and dilation outputs as shown in figure 3(c) and tumor image output as shown in figure 3(d).

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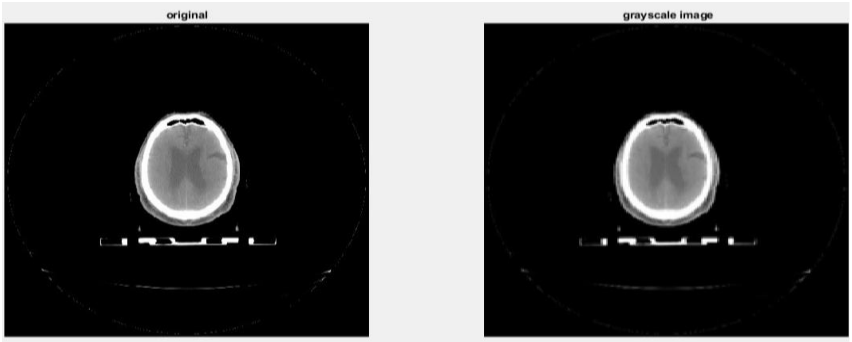

Figure 3(a): The original and gray scale images of CT scan of KUDUPUDI BABJI RAO

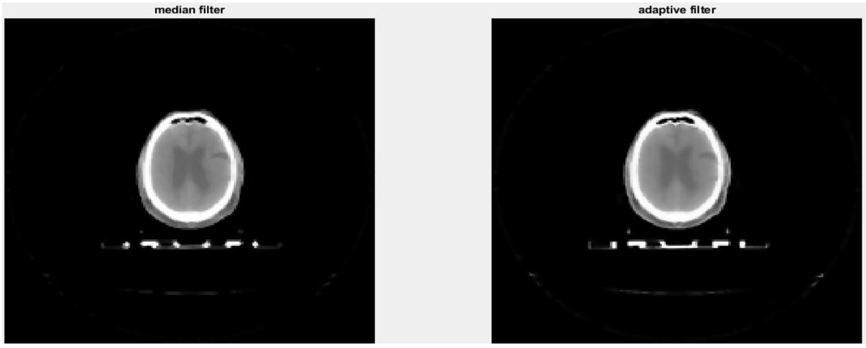

Figure 3(b): The median filter and adaptive filter outputs of CT scan of KUDUPUDI BABJI RAO

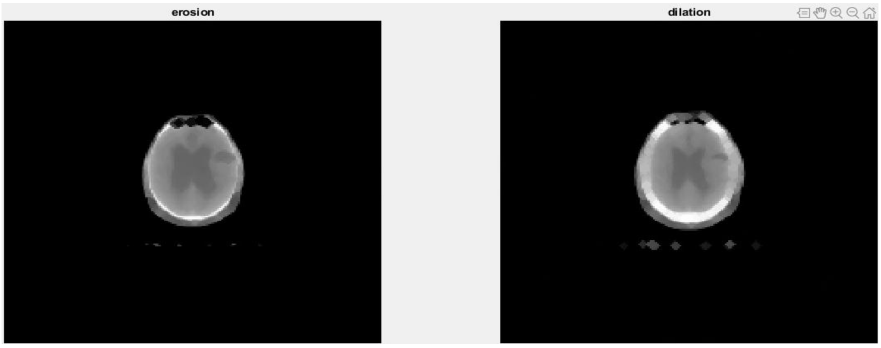

Figure 3(c): Erosion and dilation outputs of CT scan of KUDUPUDI BABJI RAO

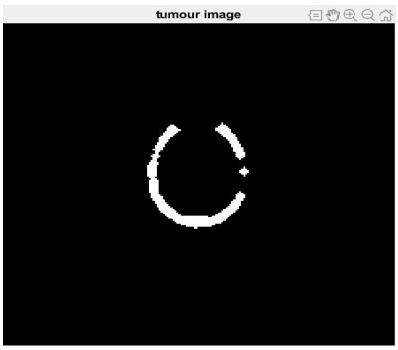

Figure 3(d): Tumour image of CT scan of KUDUPUDI BABJI RAO

The following are test results of CT scan of M.SATYANARAYANA:

By running the code on the CT scan of M.SATYANARAYANA we get the outputs as the original and gray scale image of CT scan of M.SATYANARAYANA as shown figure 4(a), the median and adaptive filter outputs as shown in figure 4(b), erosion and dilation outputs as shown in figure 4(c) and tumor image output as shown in figure 4(d).

Figure 4(a): The original and gray scale image of CT scan of M.SATYANARAYANA

Figure 4(b): The median and adaptive filter outputs of CT scan of M.SATYANARAYANA

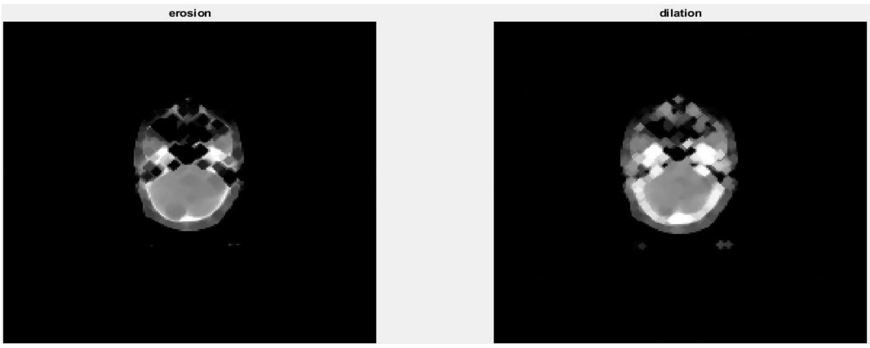

Figure 4(c): Erosion and dilation outputs of CT scan of M.SATYANARAYANA

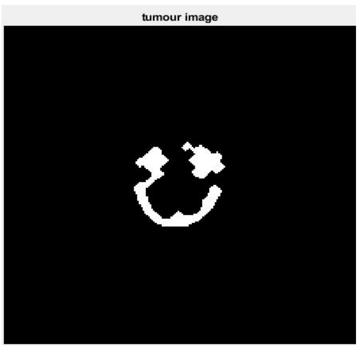

Figure 4(d): Tumor image output of CT scan of M.SATYANARAYANA

The following are the results of CT scan of PULAPARTHI BASKARA PRASAD:

By running the code on the CT scan of PULAPARTHI BASKARA PRASAD we get the outputs as the original and gray scale image of CT scan of PULAPARTHI BASKARA PRASAD as shown figure 5(a), the median and adaptive filter outputs as shown in figure 5(b), erosion and dilation outputs as shown in figure 5(c) and tumor image output as shown in figure 5(d).

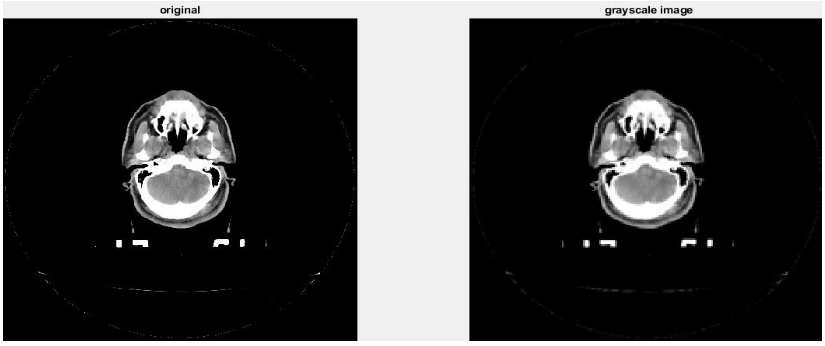

Figure 5(a): The original and gray scale image of CT scan of PULAPARTHI BASKARA PRASAD

Figure 5(b): The median and adaptive filter outputs of CT scan of PULAPARTHI BASKARA PRASAD

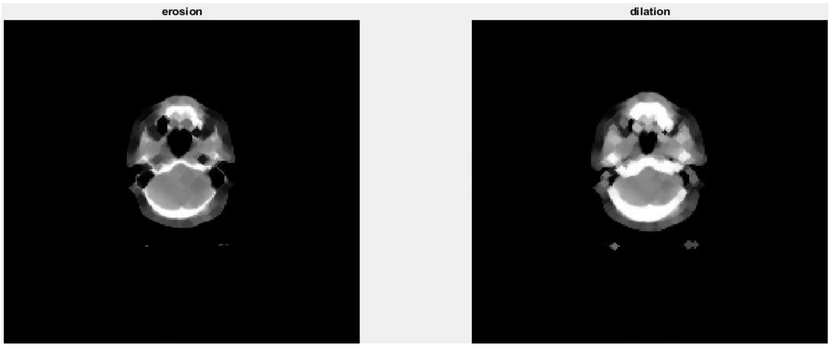

Figure 5(c): The erosion and dilation outputs of CT scan of PULAPARTHI BASKARA PRASAD

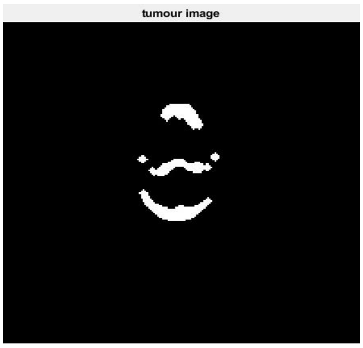

Figure 5(d): Tumor image of CT scan of PULAPARTHI BASKARA PRASAD

The following are the results of CT scan of PANJA VEERARAGHAVULU:

By running the code on the CT scan of PANJA VEERARAGHAVULU we get the outputs as the original and gray scale image of CT scan of PANJA VEERARAGHAVULU as shown figure 6(a), the median and adaptive filter outputs as shown in figure 6(b), erosion and dilation outputs as shown in figure 6(c) and tumor image output as shown in figure 6(d).

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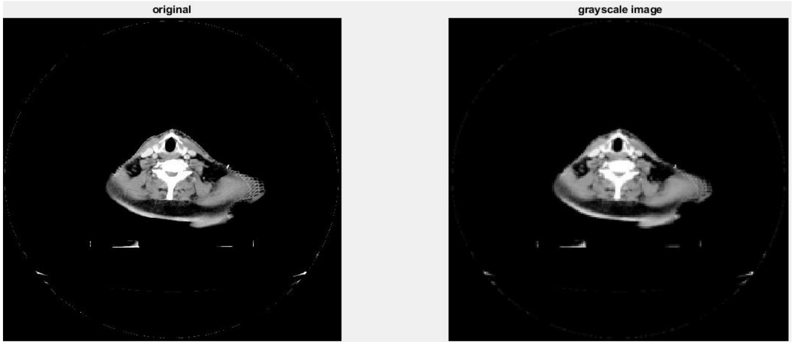

Figure 6(a): The original and gray scale image of CT scan of PANJA VEERARAGHAVULU

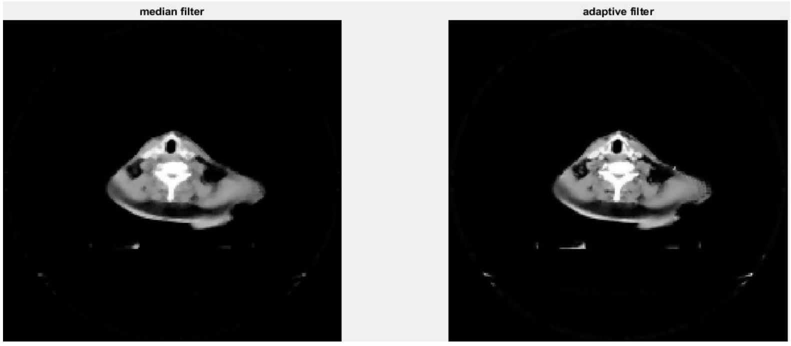

Figure 6(b): The median and adaptive filter outputs of CT scan of PANJA VEERARAGHAVULU

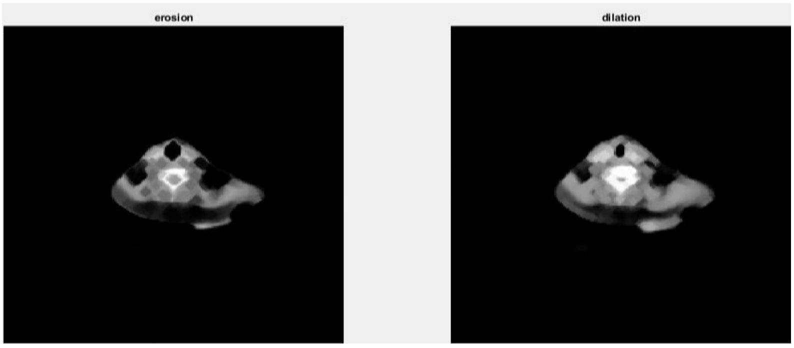

Figure 6(c): The erosion and dilation outputs of CT scan of PANJA VEERARAGHAVULU

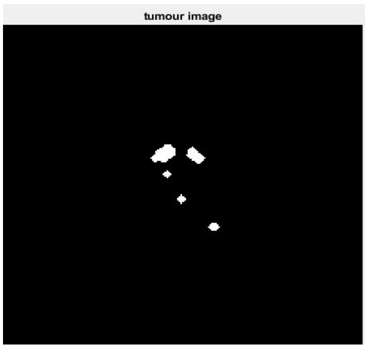

Figure 6(d): the tumor image of CT scan of PANJA VEERARAGHAVULU

The following are the results of CT scan of S DURGARAO:

By running the code on the CT scan of S DURGARAO we get the outputs as the original and gray scale image of CT scan of S DURGARAO as shown figure 7(a), the median and adaptive filter outputs as shown in figure 7(b), erosion and dilation outputs as shown in figure 7(c) and tumor image output as shown in figure 7(d).

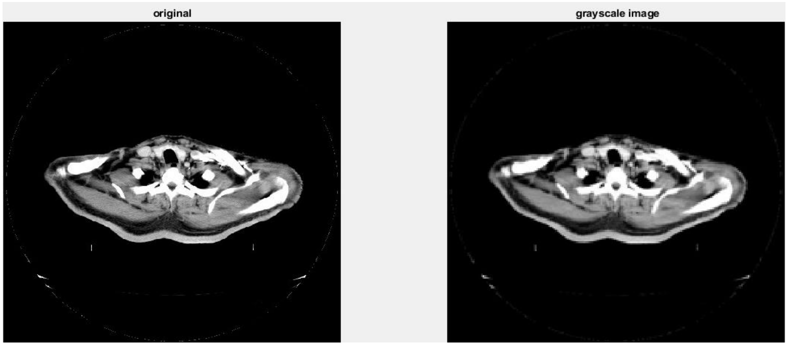

Figure 7(a): The original and gray scale image of CT scan of S DURGARAO

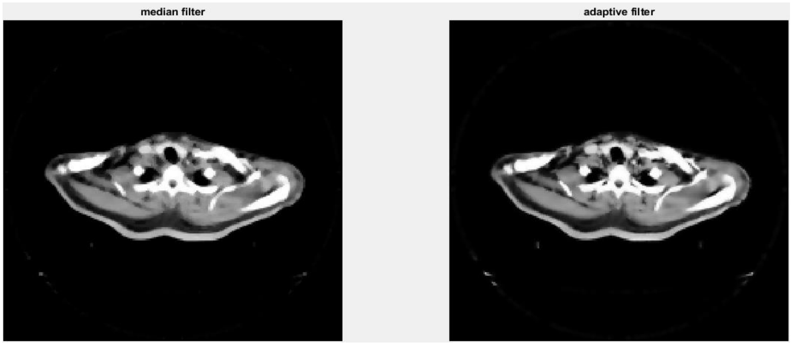

Figure 7(b): The median and adaptive filter outputs of CT scan of S DURGARAO

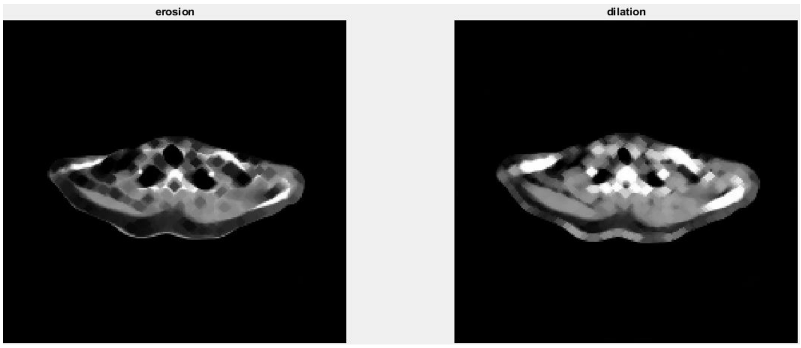

Figure 7(c): The erosion and dilation outputs of CT scan of S DURGARAO

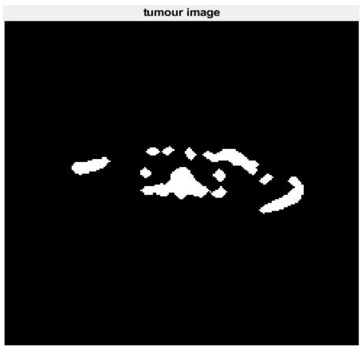

Figure 7(d): The tumor image of CT scan of S DURGARAO

The following table gives the pixel count and area of tumor in each case:

S.no	Patient Name	Pixel Count	Area Of Tumor
1.	Kudipudi Babji Rao	669	46.63
2.	M.Satyanarayana	923	64.33
3.	Pulaparthi Baskara Rao	726	50.60
4.	Panja Veeraraghavulu	217	15.12

5.	S.Durga Rao	1136	79.17

Table 1: Pixel count and area of tumor in each case

5. CONCLUSIONS

The proposed method incorporates segmentation and k-means clustering to enhance the analysis of MR images. The findings that perceive unsupervised segmentation methods are better than the guided segmentation methods. Pre-processing is required to screen images using the supervised segmentation method. The Image Segmentation Process often involves a considerable amount of training and testing data that greatly complicates the method. Nonetheless, the image analysis of the observed K-means clustering system is fairly simple as compared to commonly used fuzzy clustering methods. Here, it is shown that JPEG 2000 is a modern compression format foe still images intended to address the shortcomings of the current JPEG model. It also results in a loss of less compression with progressive decoding. The applications of digital libraries or databases and medical imaging that benefit from this function. The specification provides a collection of error-resilient devices to make the bit stream more robust for transmission errors. The regions of interest (ROIs) can be described in this mode. Such ROIs can be encoded and transmitted with better quality than the rest of the file. K-means a segmentation method dependent on tumor detection is carried out.

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