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Feature extraction to detect Bone Cancer Using Image Processing.

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ABSTRACT

Early detection of the cancer-prone area in MRI scan is of great importance for the successful diagnosis and treatment of bone cancer. This paper proposes an approach to detect bone cancer in MR images using medical image processing techniques. A proposed approach has some preprocessing techniques which use Gabor filter to smoothen the image and remove the noise from an image. The segmentation is carried out by using superpixel segmentation and multilevel segmentation. This methodology is used for identifying the bone cancer by various preprocessing techniques like filtering and gray conversion. After filtering, edge detection and morphological operations are applied. In the second stage, superpixel segmentation is performed and some of the important features are extracted from the images. Then the extracted features are used to identify the bone cancer.

Keywords: bone cancer, preprocessing techniques, superpixel segmentation, feature extraction.

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INTRODUCTION

A tumor is an abnormal growth of new tissue and that can be formed in any of the organs in our body. There are many different kinds of cancer like lung cancer, brain cancer, and bone cancer. nowadays bone cancer is considered to be one of the most dangerous and serious cancer in the world, with the smallest survival rate after the diagnosis. If cancer directly affects the bone then it is called sarcomas. Mostly the bone cancer is classified as primary or secondary. Cancer that occurs in the bone is the primary one whereas if it initially occurs anywhere in the body and affects the bone is called the secondary. There are two types of bone cancer, noncancerous (benign) and cancerous (malignant). Obtaining an accurate result in bone cancer detection is very important in many imaging application. It mainly helps to plan for the treatment at the earlier stage and for the evaluation of the therapy. The early detection of bone cancer will decrease the mortality rate. To obtain more accurate results, we divided the whole process into three stages, image processing stage, image segmentation, feature extraction, and classification. The main objective of our proposed method is to have a fast and robust system for detecting the bone cancer in early stage and to obtain a more accurate result than many other existing techniques.

LITERATURE SURVEY

Sinthia P and K. Sujatha [1] proposed a novel approach to detect the bone cancer using K-means algorithm and edge detection method. This methodology used Sobel edge detection to detect the edge. Sobel edge detector detects only the border pixels. K-Means clustering algorithm is used to detect the tumor area. Defining the number of clusters is the difficult step in K-Means clustering algorithm.

Kishor Kumar Reddy [2] proposed a novel approach for detecting the tumor size and bone cancer stage using region growing algorithm. This methodology segmented the region of interest by using region growing algorithm. Tumor size is calculated according to the number of pixel in the extracted tumor part. Depending upon the total pixel value cancer stage is identified. Selection of seed point depends on the image and it is difficult to select accurately.

Madhuri Avula [3] proposed a method to detect the bone cancer from MR images using Mean pixel intensity. The input MR image is denoised and K-Means clustering algorithm is applied to extract the tumor part. From the extracted tumor part a total number of pixel is computed and the sum of pixel intensity is calculated for the extracted tumor part to calculate the mean pixel intensity. Mean pixel intensity is calculated to identify cancer. If the mean pixel intensity value is above the threshold value it is considered as cancer.

Abdulmuhssin Binhssan [4] proposed a method to detect the enchondroma tumor. The input image is denoised using a bilateral filter and average filter. Bilateral filter has certain disadvantage It takes more time to denoise the image. The average filter provides better result compare to bilateral filter. Thresholding segmentation is carried out to segment the image and morphological operations are applied to enhance the tumor area.

Mokhled S. Al-Tarawneh [5] proposed a method of Lung Cancer Detection Using Image Processing Techniques. This methodology used Gabor filter to denoise the image. Gabor filter has the best results. To segment, the image two segmentation methods are used. Thresholding approach and marker-controlled watershed segmentation are the two algorithms. Marker-controlled segmentation technique provides better result compare to thresholding approach. The image features are extracted using binarization and masking approach to identify cancer.

Anita chaudhary [6] has developed a method of lung cancer detection on CT images by using image processing. In this methodology, Gabor filter is used for noise reduction. Segmentation is done by using two segmentation methods thresholding and marker-controlled watershed segmentation. Features are extracted to identify the tumor. Area, perimeter, and roundness are the three features extracted in this paper.

Nooshin Hadavi and Md.Jan Nordin[7] proposed a method for Lung Cancer Diagnosis Using CT-Scan Images Based on Cellular Learning Automata. This methodology used Gabor filter to remove the noise present in the input image. Region growing algorithm is used to segment the image. Various features are extracted from a segmented image and applied to the new algorithm cellular automata to identify cancer.

IMAGE PROCESSING TECHNIQUES

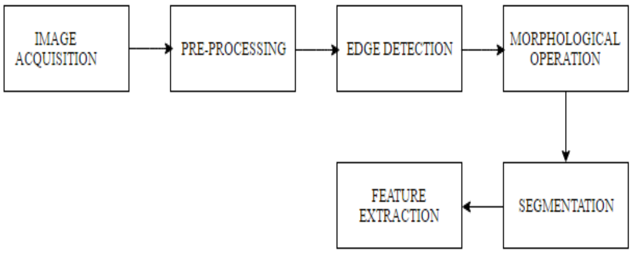

Figure 3.1 Block diagram of bone cancer detection

ACQUISITION OF IMAGE

There are different image modalities such as CT scans, MRI, and X-rays. The MR images are considered to be the best because of its higher resolution. The MRI is used to show the 2D images of the body.

Figure 3.2 Input MRI scan image

PREPROCESSING

It is a primary step to improve the quality of an image. The image processing stage is started with the filtering technique. Usually, an image contains noises such as occlusions, variations in the illuminations and so on. So these noises should be eliminated. Gabor filter is used in order to remove the noise and to smoothen the images. The main advantage of this filter is, it produces excellent noise reduction with less blurring when compared with other filters.The next step in the preprocessing is the gray conversion. This is the process of converting the pixels having RGB level into the gray level. This is carried out because the gray level image can be easily processed compared to the color image. This conversion is mainly to eliminate the hue and saturation information by retaining the luminance.

Figure 3.3 Denoised image

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Figure 3.4 Gray converted image

EDGE DETECTION

An edge detector used to obtain a boundary between two regions with relatively distinct gray level properties. Edge detection used to extract useful features for pattern recognition in cancer images. Canny edge detector is used for detecting an edge of an image. It first blurs the image and then by applying an algorithm that effectively thins the edges to one pixel. The advantage of this canny detector is good detection, good localization, and minimal response.

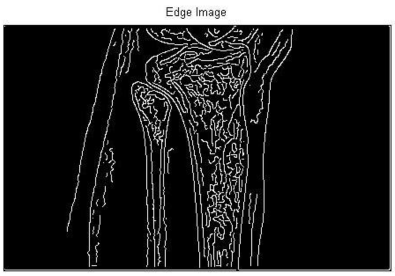

Figure 3.5 Edge detected image

MORPHOLOGICAL OPERATION

Morphological operations are used to identify shape, size, and connectivity. Two basic operations of the morphological technique are dilation and erosion. Dilation operation is used to expand the region. Erosion operation is used to erode away or to eliminate the small objects.

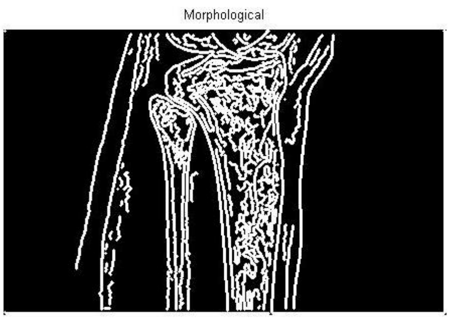

Figure 3.6 Morphological operation

SEGMENTATION

Segmentation is the process of partitioning the image into multiple segments. This methodology used superpixel segmentation and multilevel segmentation. This method segments the image into bigger pixels compare to other segmentation techniques.

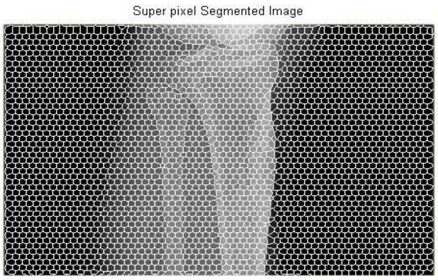

Figure 3.7 Superpixel segmentation

Figure 3.8 Multilevel segmentation

FEATURE EXTRACTION

The image feature extraction is the most important technique in image processing. It plays a major role in the detection of cancer. After segmentation is done image features are extracted from the image to detect cancer. Feature extraction is an essential stage that represents the final results to predict cancer and non-cancer of an image. Feature extraction reduces the number of resources required to describe a large set of data. It is the process by which certain features of interest within an image are detected and represented for further processing. The feature is described as a function of one or more measurements. Each feature specifies some quantifiable property of an object and is computed such that it quantifies some significant characteristics of the object.

We classified various features such as Mean, standard deviation, contrast, correlation, energy, homogeneity, entropy, RMS, variance, smoothness, Kurtosis, skewness, IDM.

Mean
Mean is the measure of the average intensity value of the pixels present in the region.

$$\frac{1}{n}\left(\sum_{i=1}^{n} X_i\right)$$

Standard deviation
Standard deviation is the measure of how much that gray levels differ from its mean.

$$\sqrt{\frac{1}{n}\left(\sum_{i=1}^{n}(X_i - \overline{X})^2\right)}$$

Contrast
Contrast is the measure of the difference between the brightness of the objects or regions and other objects within the same field of view.

$$\sum_{i,j}|i-j|^2 p(i,j)$$

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Correlation

Correlation is the measure of degree and type of relationship between adjacent pixels.

$$\sum_{i,j} \frac{(i-\mu i)(j-\mu j)p(i,j)}{\sigma_i \sigma_j}$$

Energy

Energy is the sum of squared elements in the Gray level co-occurrence of Matrix.

$$\sum_{i,j} p(i,j)^2$$

Homogeneity

Homogeneity is the closeness of the distribution of elements in the GLCM.

$$H= \sum_{i,j} \frac{p(i,j)}{1+|i-j|}$$

Entropy

Entropy characterizes the texture of the image.

E=sum (p.*log2(p))

RMS

RMS is the measure of root mean square value of an image.

$$X_{\mathrm{RMS}} = \sqrt{\frac{1}{N}\sum_{n=1}^{N} |X_n|^2}$$

Variance

Variance is the measure of variance value of an image.

$$\frac{1}{n}\left(\sum_{i=1}^{n} (X_i - \overline{X})^2\right)$$

Smoothness

Smoothness is a measure of relative smoothness of intensity in a region.

Kurtosis

Kurtosis is a measure of peaks distribution related to the normal distribution.

$$k = \frac{E(x-\mu)^4}{\sigma^4}$$

Skewness

Skewness is a measure of asymmetry in a statistical distribution.

$$s = \frac{E(x-\mu)^3}{\sigma^3}$$

IDM

Inverse difference moment is a measure of image texture usually called homogeneity. IDM features obtain the measure of the closeness of the distribution of GLCM elements to the GLCM diagonal.

$$m_k = E(x-\mu)^k$$

Various features are extracted from 10 bone cancer patients and the extracted feature values are tabulated below in Table 3.1.

Table 3.1 Feature extraction of bone cancer patients

Features	Patient1 Abnormal	Patient2 Abnormal	Patient3 Abnormal	Patient4 Normal	Patient5 Normal	Patient6 Abnormal	Patient7 Abnormal	Patient8 Abnormal	Patient9 Normal	Patient10 Abnormal
Contrast	0.1328	0.1951	0.2651	0.23	0.2129	0.5458	0.4956	0.4767	0.3379	0.2554
Correlation	0.1618	0.1522	0.1305	0.1618	0.1628	0.167	0.1326	0.1634	0.1253	0.1706
Energy	0.8927	0.92	0.8369	0.8711	0.8234	0.7822	0.7294	0.7438	0.7779	0.8616
Homogeneity	0.9709	0.9763	0.9532	0.9634	0.9509	0.9334	0.9221	0.9227	0.9357	0.9604
Mean	0.0022	0.0026	0.0032	0.0029	0.002	0.0059	0.0024	0.008	0.0047	0.003
Standard Deviation	0.064	0.0634	0.0821	0.0753	0.0811	0.1116	0.1147	0.1063	0.09273	0.079
Entropy	2.6426	1.3506	3.1958	2.3544	2.7827	3.0852	2.9799	2.444	3.206	1.6063
RMS	0.064	0.0635	0.0822	0.0754	0.9589	0.1118	0.1147	0.1066	0.0928	0.079
Variance	0.0041	0.004	0.0068	0.0057	0.0066	0.01241	0.01299	0.0113	0.0086	0.0062
Smoothness	0.956	0.9822	0.9721	0.9749	0.9589	0.9122	0.8021	0.9623	0.9678	0.978
Kurtosis	21.6003	47.2263	17.2783	26.5633	14.3405	15.662	12.5391	12.2595	1.0927	23.8225
Skewness	1.2933	3.287	1.5316	1.9942	1.0993	1.711	1.1937	1.1352	1.3078	1.6517
IDM	-0.0605	-0.0836	1.503	2.0195	-2.0379	0.2737	-0.0971	0.7171	0.2462	2.2526

EXPERIMENTAL RESULTS

The work was tested on MRI images of bone cancer patients. The MATLAB application with

Graphical User Interface (GUI) was developed to enable users to perform interactive tasks.

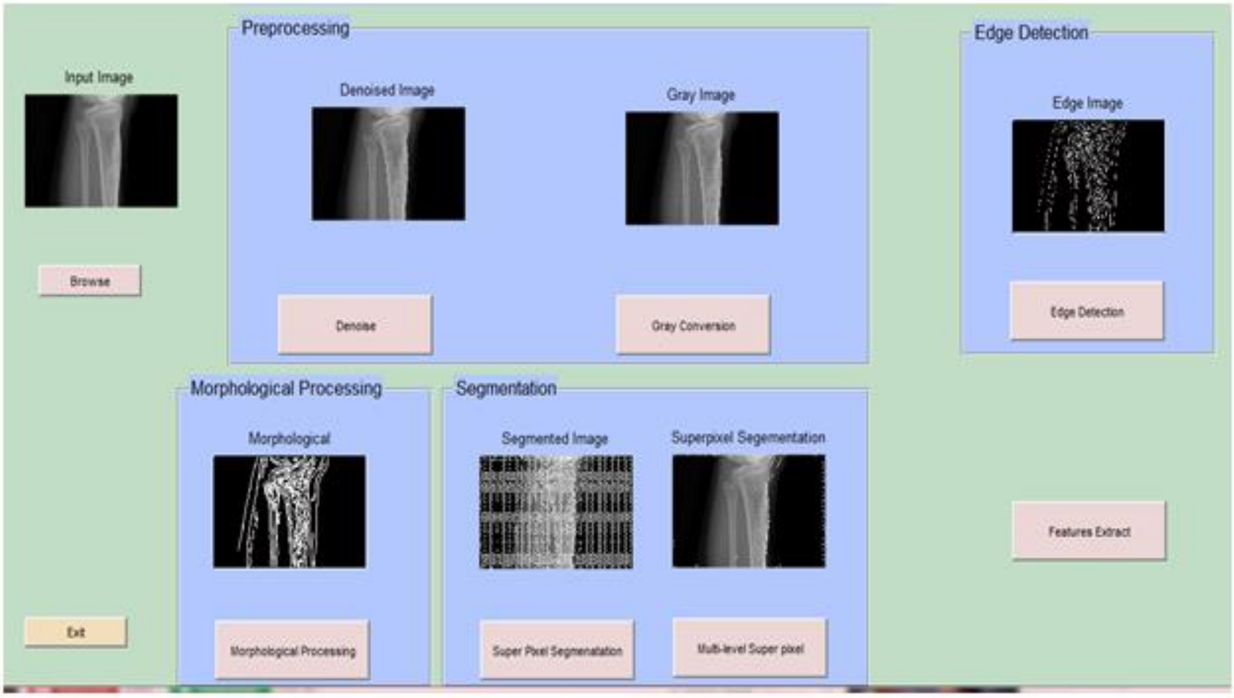

Figure 3.10 a) Input image b) Denoised image c) Gray converted image d) Edge detection e) Morphological operation f) Superpixel segmentation g) Multilevel segmentation f) feature extraction

The performance analysis of extracted features are represented as bar graph in Figure 3.11. The classification of benign and malignant cancer was done based on extracted feature values.

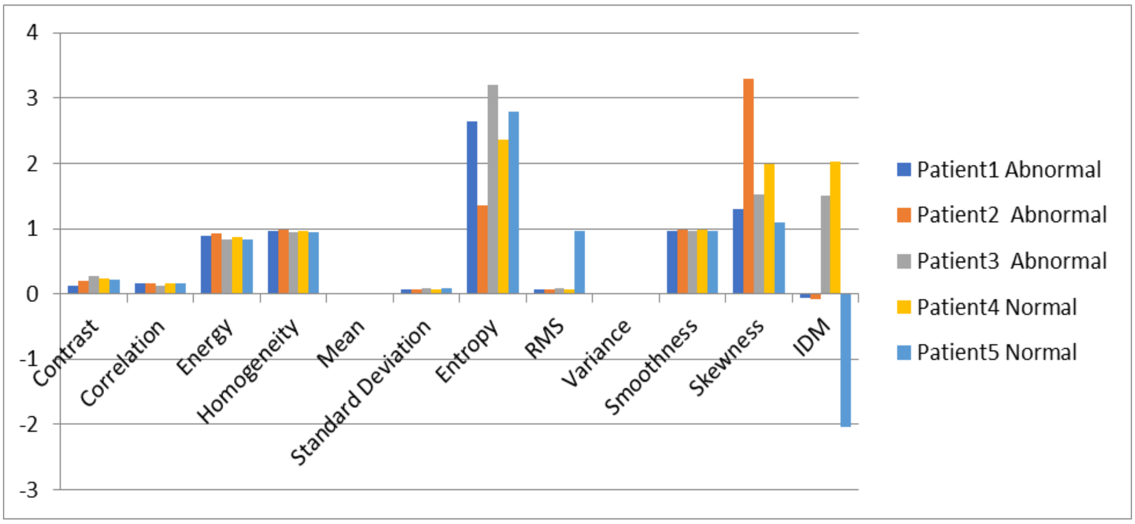

Figure 3.11 Performance analysis of feature extraction

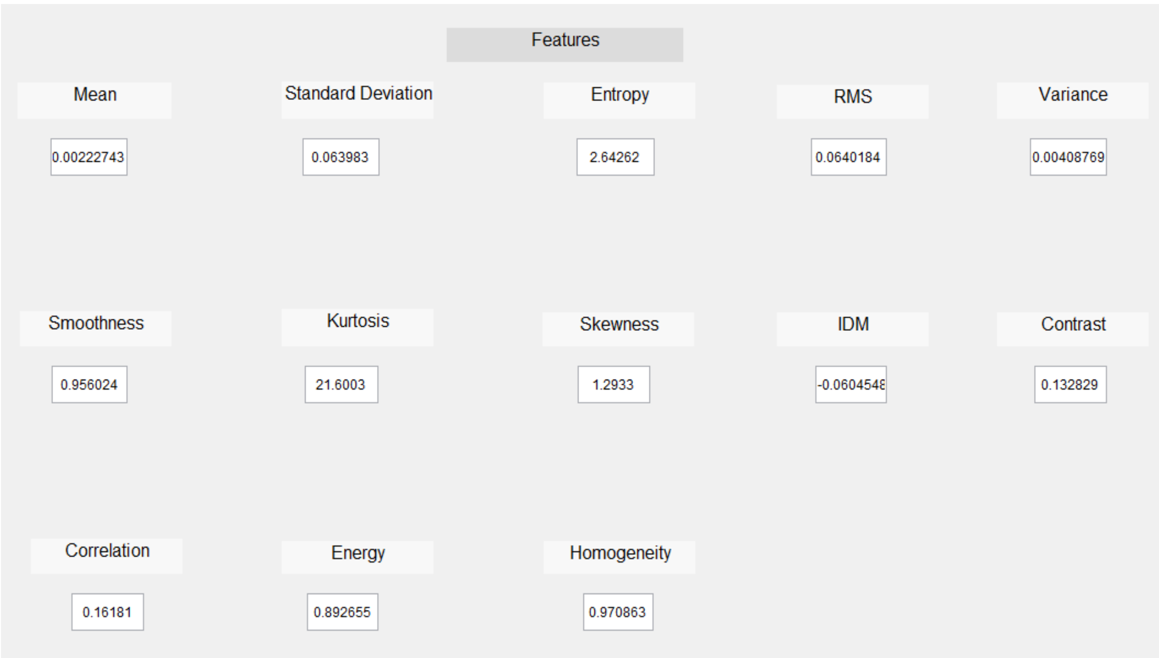

Figure 3.12 Feature extraction values for various features

CONCLUSION

Bone cancer is one kind of dangerous diseases, so it is necessary to detect cancer in its early stages. But the detection of bone cancer is the most difficult task. From the literature review, many techniques are used for the detection of bone cancer but they have some limitations. In our proposed method pursue approaches in which the first step is preprocessing, edge detection, morphological operation, segmentation and then feature extraction. The proposed system successfully detects the bone cancer from MRI scan images. The system achieves its desired expectation at the end of the system. The extracted features from the image contain some specific information to understand the details of the image. The main purpose of extracting the features is to reduce the process complication and also to isolate various desired shape of the image. The accuracy of the classification stage can be improved by extracted features. Future work can be done with the use of extracted features for the process of classification using Artificial Neural Network.

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