Feature Extraction for Skin Cancer Lesion Detection

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Abstract---**The use of image processing for the diagnostic purpose is non-invasive technique. Automatic image analysis method is the heart of image processing. In medical field it can be used to provide the quantitative information about lesion. It is nothing but the early warning tool to avoid the future problems during the treatment. Early stage detection of lesion is necessary and basic step. This needs to be achieved without performing any penetration in the body as a form of injection. The simple way is to investigate the digital images of skin lesions. Feature extraction is the important tool which can be used to analyze and explore the image properly. First different images have been segmented and features are extracted from these images. The proposed system includes the simplest method of segmentation. It does not involve user interaction as well as there is no need to change any parameter for different skin lesions.**

Keywords----Segmentation, Supervised, Unsupervised, Melanoma, Features, Image Processing, Dermatoscopy.

I. Introduction

Human Cancer is a class of diseases characterized by out-of-control growth of cell. Over 100 types of cancer are there. These types are classified by the cell that is initially affected. The uncontrollable growth of cell harms the body by forming lumps or tumors (masses of tissues). These tumors can grow and get in the way of digestive, nervous and circulatory systems. Hormones released by them cause the changes in normal body functions. The types include breast, lung, skin, kidney, etc.

Among all types skin cancers are very common in human. They are due to the development of abnormal growth of cells which spread over the other part of body. These are classified in main 2 types: Melanoma and Non-Melanoma. Melanoma skin cancer is most violent or destructive type and more dangerous if not treated early. Non- melanoma skin cancer is very common. It occurs in at least 2-3 million people per year. Globally it accounts at least 40 % of cases. Being more specific it is often observed among those people having light skin.

The mortality and morbidity of patients can be reduced by early finding and treatment of skin cancer.

II. Basic theory

The system consists of two main components: 1) Image Segmentation and 2) Feature Extraction. The system should be able to read the input image and perform the proper segmentation in order to have clear and accurate lesion. Also it should extract the features from the segmented output image. The features are consisting asymmetry, border, diameter and color of lesion.

1. Image Segmentation :

In image analysis the segmentation is most important step as it has great effect on accuracy of system. But the main obstacle is great varieties of lesion sizes, shapes and colors. Also different skin types and textures lead to complexity of system. With this lesions having irregular boundaries are also difficult to segment. To account these problems, numbers of algorithms are proposed. These algorithms are classified as thresholding, edge-based and region-based methods.

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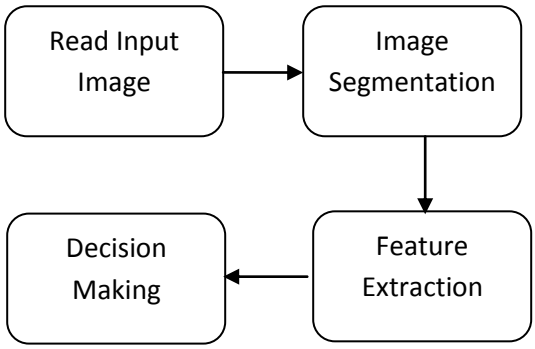

Fig 1: Basic Block Diagram

Also based on user interaction or interference these segmentation methods are classified in 2 classes: Supervised and Unsupervised.Supervised methods involve the interaction of user and also in some cases parameters need to be changed. In case of unsupervised method, the user interaction is not required and does not require the change in parameters of skin.

The proposed system consists of the Otsu's segmentation method. This is fully unsupervised method.

II. Feature Extraction :

Early detection of lesion is very important and crucial step in the field of skin cancer treatment. There is a great significance if this will be achieved without performing any penetration in the body as a form of injection. The simple way is to investigate the digital images of skin lesions. Feature extraction is the important tool which can be used to analyze and explore the image properly.

The feature extraction is based on the ABCD rule of dermatoscopy. The ABCD stands for Asymmetry, Border structure, Color variation and Diameter of lesion. It defines the basis for diagnosis of disease.

III. Methodology

As already discussed there are two main steps in the proposed system. i.e. 1) Image Segmentation and 2) Feature Extraction. The proposed system block diagram can be given as follows:

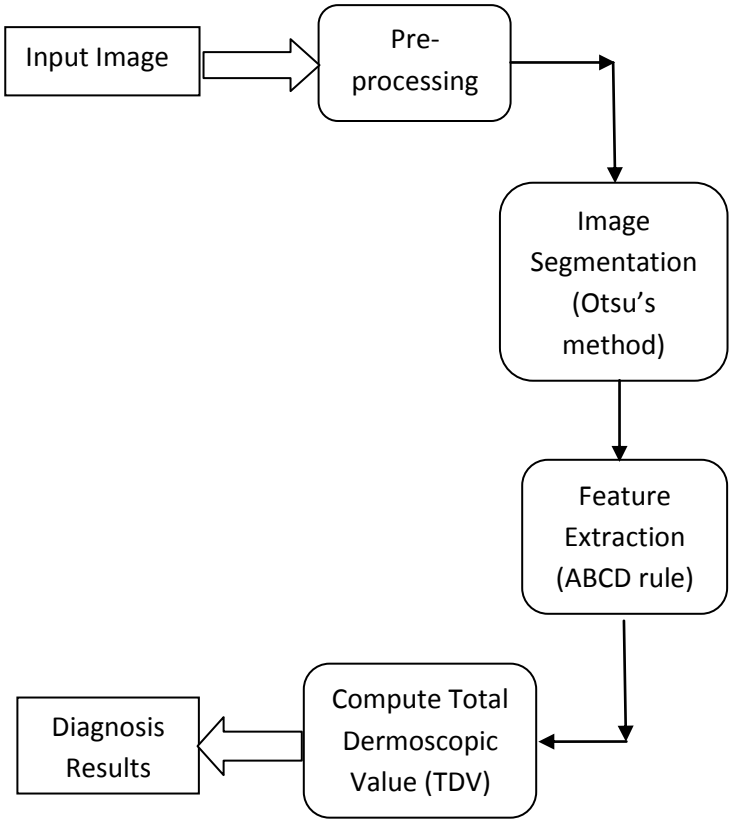

Fig 2: Proposed system block diagram

The proposed block diagram consists of two main phases: 1) Image Segmentation using OTSU's method 2) Feature Extraction using ABCD formula. Above steps are briefly described below.

I. Image Segmentation:

Image segmentation is the first step in the early detection of lesion. With image segmentation, the lesions can be detected and separated accurately and precisely.In proposed system image is segmented using the OTSU's method. This method is fully unsupervised method. It does not involve any user interaction.

OTSU's method is finest method for thresholding the objects (lesions) from the background skin. In this method the image is classified into two classes. Image with L gray levels is given as input. This method divides the image into two classes C_0={o, 1, 2,… t}and C_1 = {t+1, t+2, t+3, ….., L-1}. The probability of occurrence of gray level i is given by:

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$$pi = \frac{n_i}{n}$$

P_i = Probability of occurrence of gray level i.

n_i = Number of pixels in gray level i.

n = Total number of pixels in an input image.

These classes C_0 and C_1 represent the object of interest (lesion) and the background. The probability of these classes W_0 and W_1 are given by

$$W0 = \sum_{t=0}^{t} p_i \; and \; W1 = \sum_{i=t+1}^{L-1} p_i$$

Thus, the mean of the two classes can be computed as:

$$\mu 0(t) = \sum_{i=0}^{t} \frac{ip_i}{W0(t).\mu 1(t)} \text{ and } u1(t) = \sum_{i=t+1}^{L-1} \frac{ip_i}{W1(t)}$$

An optimal threshold t* can be obtained by maximizing the class variance:

$$t^* = Arg\left\{0 \le i^{Max} \le L-1 \frac{\sigma_B^2}{\sigma_T^2}\right\}$$

Where, Class Variance is

$$\sigma_B^2 = W0\big(\mu 0(t) - \mu 1(t)\big)^2 + W1\big(\mu 1(t) - \mu 1(T)\big)^2$$

Total Variance is

$$\sigma_T^2 = \sum_{i=0}^{L-1} (i - \mu T)^2$$

Total Mean is

$$\mu T = \sum_{i=0}^{L-1} ip_i$$

Thus by putting all these values in t* equation which results in

$$t^* = \text{Arg} \left\{ \max_{0 \le i \le L-1} \text{W0}\,(\mu o(t) - \mu 1(t))^2 + \text{W1}\,(\mu 1(t) - \mu T(t))^2 \right\}$$

II. Feature Extraction:

The feature extraction is based on the ABCD-rule-of-dermatoscopy. ABCD stands for Asymmetry, Border structure, Color variation and Diameter.

A. Asymmetry:

Symmetry is one of the very important features in image analysis. If the half part is missing or noisy, then by using symmetry feature full pattern can be obtained and rid the noisy part. Degree of symmetry can be checked using the Asymmetry Index. It is calculated using below formula.

$$AI = \frac{1}{2} \sum_{k=1}^{2} \frac{\Delta Ak}{A_L},$$

B. Border Structure:

Border structure can be analyzed by calculating Compact Index, Fractal Dimension and Edge Abruptness.

a. Compactness Index:

Compact Index is used to measure the most famous form of barriers which estimates unanimous 2D objects. However, along boundary this measure is very sensitive to noise. The value of CI is determined by using below equation:

$$\text{CI} = \frac{P_L^2}{4\pi A_L}$$

b. Fractal Dimension:

Fractal dimension is an integer value. For line, filed and cube the values is 1, 2 and 3 dimension respectively. However, in case of fractal dimension it may worth fraction. By using Box Counting method, fractal dimension can be calculated and for this Hausdorff dimension method is used. In this method the image is divided into the boxes.

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c. Edge Abruptness:

Edge abruptness is nothing but irregular boundaries. Lesion with irregular boundaries has large difference in radial distance. The estimation of barrier regularity is done by analyzing the distribution radial distance difference.m_d is mean distance of d_2 between centered point and barrier

$$C_r = \frac{\frac{1}{P_L}\sum p \in C\,(d_2(p, G_L) - m_d)^2}{m_d^2}$$

d. Pigment Transition:

This feature describes the transition of skin pigmentation between the lesion and surrounding skin. Here we calculate the mean and variance of the gradient of pigment transition which describe the transition between the injury and the setting points of skin on each side i.e level of steepness.

C. Color Variation:

The emergence of color variation in the color is early sign of melanoma.Because melanoma cells grow in grower pigment, they are often colorful around brown, or black, depending on the production of the melanin pigment at different depth in the skin. The descriptors of color are mainly statistical parameters calculated from different color channels, like average value and standard deviation of the RGB or HSV color channel. Here color variance of the RGB image has been calculated using HSV channel.

D. Diameter:

Melanoma tends to grow larger than common moles, and especially the diameter of 6mm. Because the wound is often irregular forms, to find the diameter, draw from all the edge pixels to the pixel edges through the midpoint and averaged.

After the value of four components is found, then calculate TDV (Total Dermatoscopic Value). To get the TDV values, the formula is obtained as follows:

$$TDV = A \cdot 1.3 + B \cdot 0.1 + C \cdot 0.5 + D \cdot 0.5$$

Then the value obtained has the following conclusion that are 1.00 - 4.75 - benign skin lesion, 4.75 - 5.45 - suspicious, morethan 5.45 – melanoma.

IV. Experimental Results

In first phase of segmentation, the input image is segmented using OTSU's method. Fig.3(a) shows the original RGB image. Then, the grayscale image transformation applied on it. The resultant grayscale intensity image has been displayed on Fig. 3 (b). After this, the Otsu's thresholding method has been applied on the grayscale intensity image. This gives the desired segmented image which has been shown on Fig.3(c).

In second phase of feature extraction, four features (Asymmetry, Border, Color Variation and Diameter) are extracted. By using below formula for the calculation of Total Dermoscopic Value (TDV), the value TDV is determined. Fig. 4 shows the value for TDV for provided input image. Table 1 show the criteria for the decision of cancer which is based on the value of TDV. For provided input image we got the TDV value as 5.64 which is greater than 5.45. Thus provided input image is detected as melanoma cancer.

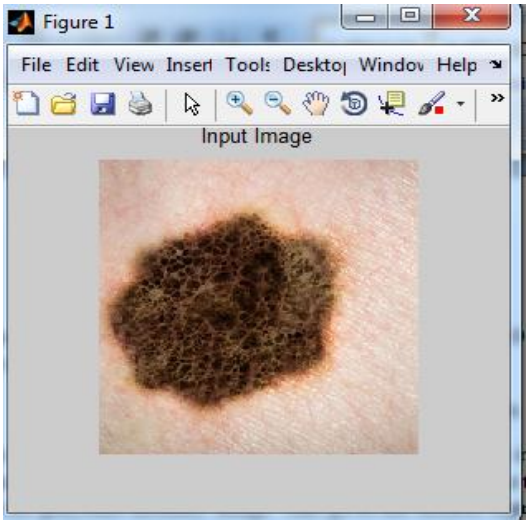

Fig 3: a) Input Image

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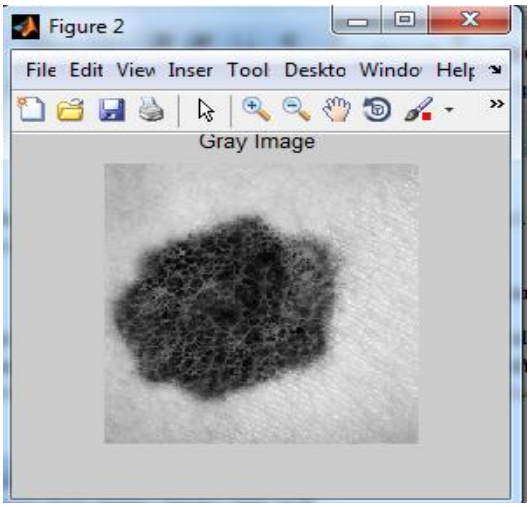

Fig 3: b) Grayscale Image

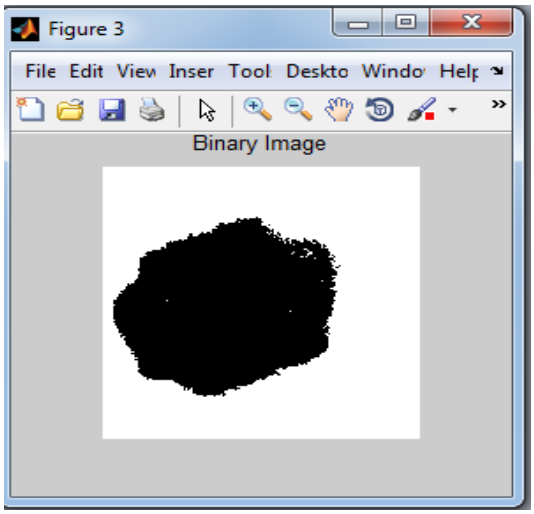

Fig 3: c) Binary Image

TDV Value	Cancer
1.00-4.75	Benign Skin Lesion
4.75-5.45	Suspicious Lesion
> 5.45	Melanoma Lesion

Table 1: Decision about Cancer

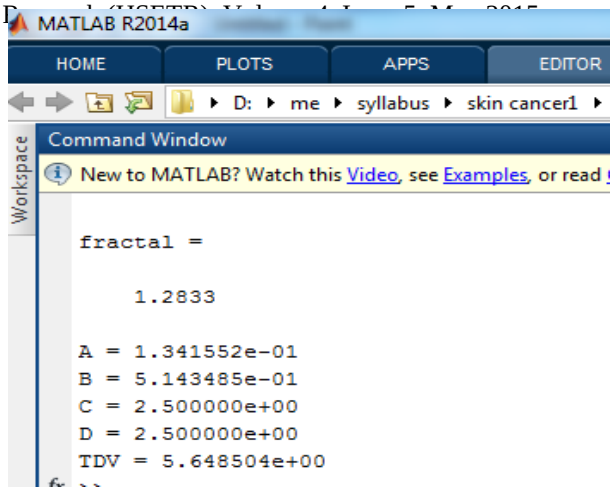

Fig 4: TDV Calculation

V. CONCLUSION

Melanoma skin cancer has been rising since last two decades, hence effective and fast cancer detection methodis of very much importance. If detected at earliest stage, cancer has highest cure rate and treatment is quite simple and economical.

The proposed system has mainly two phases to detect the melanoma.First phase is Otsu's segmentation method which is fully unsupervised and requires no changes in the skin parameters. Because of unsupervised nature it is easy to implement and provides best segmentation results.

Second phase is Feature Extraction which defines the basis of diagnosis of disease. There are three diagnosis i.e Melanoma, Suspicious and Benign. The decision of diagnosis is based on the value of TDV. Feature extraction is done using the ABCD rule of dermatoscopy, where ABCD stands for Asymmetry, Border structure, Color variation and Diameter of lesion. Once the values for features are extracted, TDV value is calculated. If TDV finds to be > 5.45 then Melanoma Lesion cancer is detected.

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