



Automatic Skin Cancer Detection in Melanoma Images using L^*a^*b and Region Growing

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Abstract: *Melanoma is the most aggressive skin cancer. In this paper, we describe an automatic system for inspection of pigmented skin lesions and melanoma diagnosis, that supports images of skin lesions, acquired using a digital camera. This allows the estimation of the personal risk of melanoma. FCM clustering is used to diagnose the melanoma. In second step we used region growing for further enhancement to detect lesion area. We found that our method classified images with a specificity of 97% and sensitivity of 99%.*

Keywords: *Skin cancer, Image Classification, Fuzzy C- mean (FCM), L^*a^*b , Illumination, Region growing, Texture analysis, MATLAB.*

I. INTRODUCTION

An image is an artifact that depicts or records visual perception [1]. An image may be two dimensional such as a photo, screen display and as well as a three dimensional such as a hologram or a statue. Image may be captured by an optical device such as cameras, mirrors, lens, telescopes, microscopes etc. Mining of biomedical image data is a complex procedure that requires several processing phases [2]. Especially, in the case of biomedical images, proper preprocessing, feature extraction, and classification are required. The scientific field of image mining deals with the extraction of features representing meaningful information from images. Malignant melanoma is the third most frequent type of skin cancer and one of the most malignant tumors. A malignant melanoma diagnosed at an early stage can be cured without complications. The early diagnosis of malignant melanoma is therefore a crucial issue for dermatologists. The main objective of such systems is to facilitate the dermatologist in different analysis steps, such as the lesion boundary detection, diagnostic features, the classified into different classes of lesions, the visualization, storage, the database management, etc. In the US, at current rates, a skin cancer will develop in one in five people during their lifetime [4]. Skin cancers can be classified into two major groups which are melanoma and non-melanoma skin cancers.

The early detection of melanoma can be activated in the following diagnosis method they are, asymmetry. This asymmetry is verified with respect to a point under one or more axes [4], border, color, differential structure, pattern analysis method looks for identify specific patterns, which may be reticular, globular, flagstone, parallel, nonspecific or pigment network, Menzies method seek to identify negative and positive features [4], JSEG algorithm [5], fuzzy border [6], MSIM algorithm [7], sparse texture model algorithm [8], k -means clustering[9], adaptive boosting multi-label learning algorithm [10], gray level co-occurrence matrix (GLCM) is discussed here and wavelet decomposition matrix (WDM) and various types of classifiers are used [11], The detection of melanoma based on region growing segmentation and ABCD rule used for the detection of pigmented skin lesion is discussed[12].

II. SYSTEM FRAMEWORK

Biomedical image processing is a very broad field; that covers biomedical signal gathering, image forming, image processing, and image display to medical diagnosis based on features extracted from images. Medical imaging is the technique and process of creating visual representations of the interior of a body for medical intervention. Medical imaging seeks to acknowledge internal structures hidden by the skin and bones, as well as to diagnose and treat disease. Medical imaging also establishes a database of normal anatomy and physiology to make it possible to identify abnormalities. The combination of both hardware and software leads to clinical imaging devices. Skin is the largest organ in our body. Cancer is a group of diseases characterized by uncontrolled growth and spread of abnormal cells. If the abnormal cell is not composed, it can result in death.

In this paper we describe the system. Its overall workflow is shown in Fig. 1. In Section II, we describe the image processing and the segmentation algorithm. In Section III we explain how we derive the features according to the dermatoscopic criteria. These features are used by a classifier, which is discussed in Section IV. The usage of context knowledge, which integrates the patient risk profile into the decision support system is explained in Section V. The results of validation are presented in Section VI. We finalize with conclusions in Section VII. We are taking total 75 number of melanoma sample

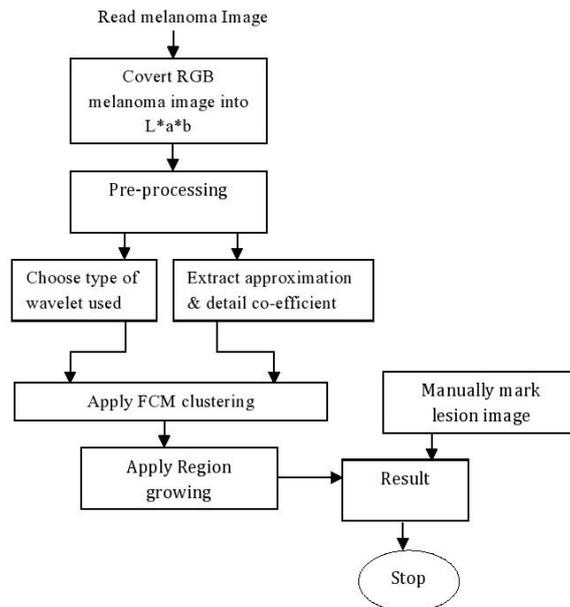


Fig.1: Proposed System framework



Fig.2: Different types of melanoma images taken from collected database

2.1 Image Acquisition

As Digital Camera is not capable of taking the inside images of the skin. For this a Dermoscope is required. Images of melanoma are captured using the technique dermoscopy or epiluminescence microscopy. It uses equipment called dematoscope to observe and capture the skin lesion closely.. For lesion recognition firstly upload the melanoma image as shown below in MATLAB environment.

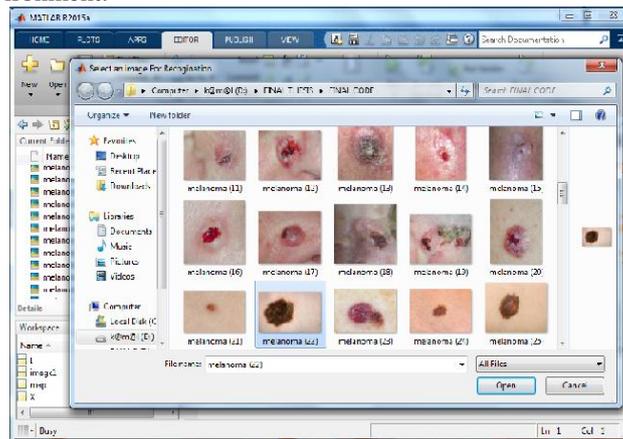


Fig.2.1: Melanoma image is uploaded successfully

2.2 L*a*b colour space

The $L^*a^*b^*$ colour space is considered as a perceptually uniform colour space transform, which means that distances calculated in this space correspond to difference as the human visual system perceives. Convert Image from RGB Color Space to $L^*a^*b^*$ Color Space. The $L^*a^*b^*$ color space (also known as CIELAB or CIE $L^*a^*b^*$) enables us to quantify these visual differences. The $L^*a^*b^*$ space consists of a luminosity layer ' L^* ', chromaticity-layer ' a^* ' indicating where color falls along the red-green axis, and chromaticity-layer ' b^* ' indicating where the color falls along the blue-yellow axis. All of the color information is in the ' a^* ' and ' b^* ' layers. We can measure the difference between two colors using the Euclidean distance metric.

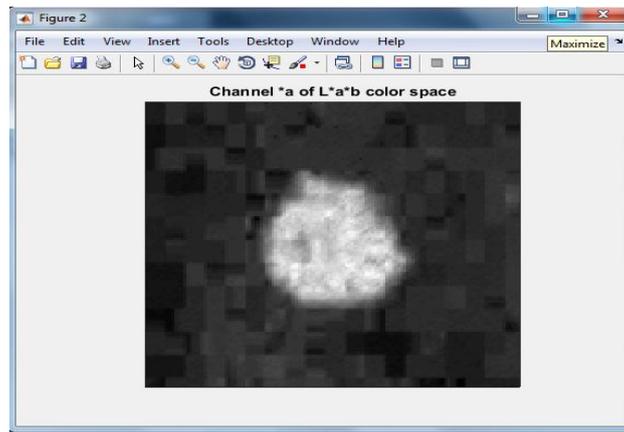


Fig.2.2: Original Image Converted in to L*a*b

2.3 Preprocessing

Preprocessing is a compulsory task to be done on the images accomplished using dermoscopy. It is vital because the captured image may not be clear. Human skin surface will be seized by hairs, scars and skin texture differences. Hence, the images should be preprocessed to approach the affected skin lesion accurately. An image can be preprocessed in various ways. They are: Hair removal, noise filtering, black frame removal, image equalization, contrast enhancement etc., these techniques are narrated as below:

2.3.1 Wavelet transformation

Wavelet transform decomposes a signal into a set of frequency channels that have narrower bandwidths in the lower frequency region. Two-dimensional wavelet transforms to obtain the energy map and the dominant frequency channels. Decomposition of a channel is determined based on the ratio of the average energy of that channel to the highest average energy of a channel at the same level of decomposition. If the energy ratio exceeds a predetermined threshold value, the channel is decomposed.

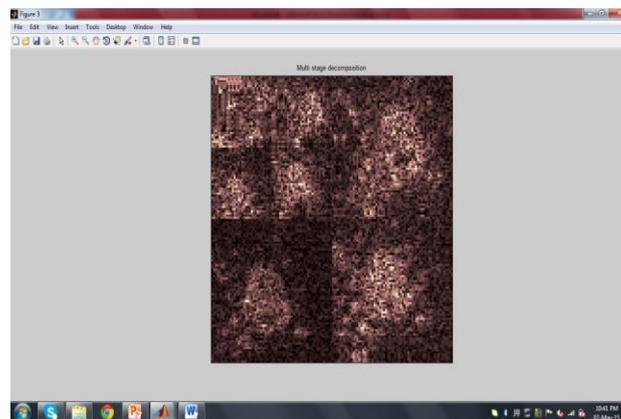


Fig.2.3.1: Melanoma image after using wavelet transformation

2.3.2 Discrete wavelet transform (DWT)

After wavelet transformation is done using DWT two level decomposition (dB 10). Discrete wavelet transform (DWT) has been widely adopted in biomedical signal processing for denoising, compression and so on for further enhancement of melanoma image.

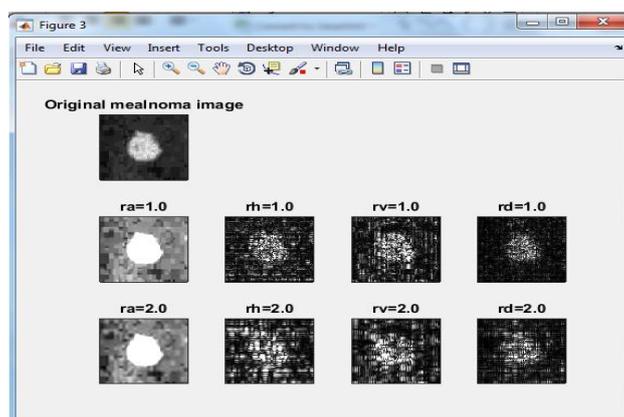


Fig.2.3.2: Two level decomposition (dB 10).

III. FUZZY C-MEAN (FCM) FOR INITIAL SEGMENTATION

FCM is a method of clustering which allows one piece of data to belong to two or more clusters. The main difference between the traditional hard clustering and fuzzy clustering can be stated as follows. While in hard clustering an entity resides only to single cluster, in fuzzy clustering entities are allowed to reside too many clusters with deferent degrees of membership. The most known method of fuzzy clustering is the Fuzzy c-Means method which is being most widely used in image processing applications. The steps involved in FCM are briefed as below.

The following is description of the FCM algorithm, which is implemented *Fuzzy Logic*.

1. Select the number of clusters c ($2 \leq c \leq n$), exponential weight μ ($1 < \mu < \infty$), initial partition matrix U^0 , and the termination criterion ϵ . Also, set the iteration index l to 0.
2. Calculate the fuzzy cluster centers $\{v_i^l \mid i=1, 2, \dots, c\}$ by using U^l .
3. Calculate the new partition matrix U^{l+1} by using $\{v_i^l \mid i=1, 2, \dots, c\}$.
4. Calculate the new partition matrix $\Delta = \|U^{l+1} - U^l\| = \max_{i,j} |u_{ij}^{l+1} - u_{ij}^l|$. If $\Delta > \epsilon$, then set $l = l + 1$ and go to step 2. If $\Delta \leq \epsilon$, then stop.

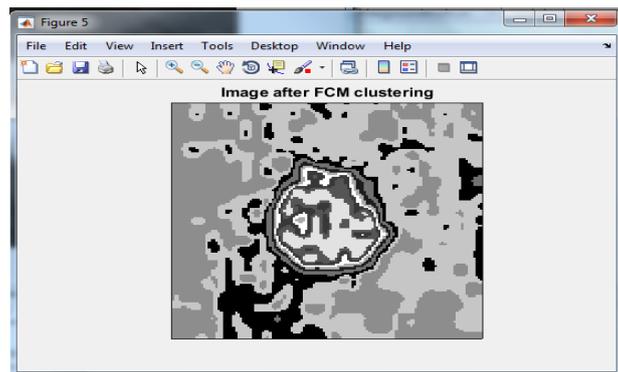


Fig.3.1: Melanoma image occurred after apply fcm.

After applying FCM on 'a' channel of $L*a*b$ color spaced image, the cluster with maximum average intensity in 'a' channel has been extracted out, which provides seed point to the region growing.

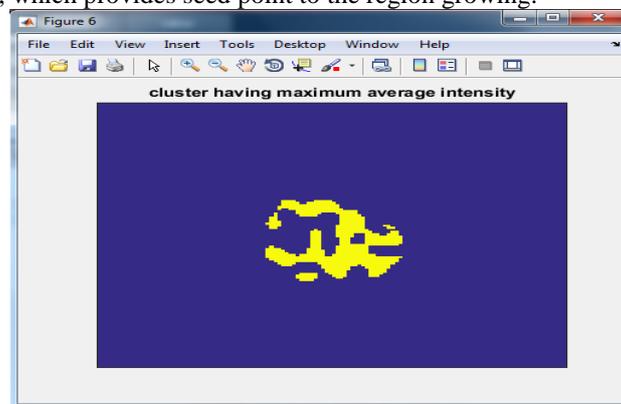


Fig.3.2: Select cluster having maximum intensity

IV. REGION GROWING ALGORITHM

The basic idea of region growing is a collection of pixels with similar properties to form a region [13]. First, we need to find a seed point as a started point for each of needed segmentation. And then blend the same or similar property of with the seed pixel around the seed pixel domain into the domain of seed pixel. These new pixels as a new seed point to continue the above process until no more pixels that satisfy the condition can be involved, and then the region has grown.

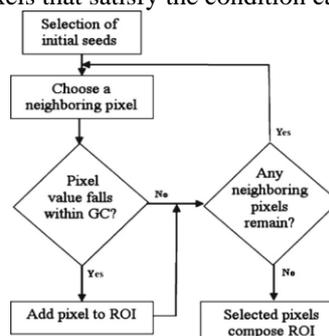


Fig 4.1: Flowchart for region growing algorithm

The application of this method we need to address three questions: first, choose or determined a group of seed pixel which can correctly represent the required region; second, fixed the formula which can contain the adjacent pixels in the growth; third, made rules or conditions to stop the growth process.

This article according a certain rules to automatic select seed pixels as well as effective solve the first question. We carry on the regional growing on the basis of the watershed segmentation algorithm; this method effectively solved the second questions. Domain decomposition technique makes seed region continually split into four rectangular regions until the internal of every region is similar. Region merging is often combines with the region growing and domain decomposition in order to merge the similar sub-region into a domain as large as possible.

- Pixels must be homogeneous with respect to few properties, inside one region.
- Pixels must have distinct properties with respect to pixels from other region. Region growing formula must be time efficient and able to segment a wide range of images.

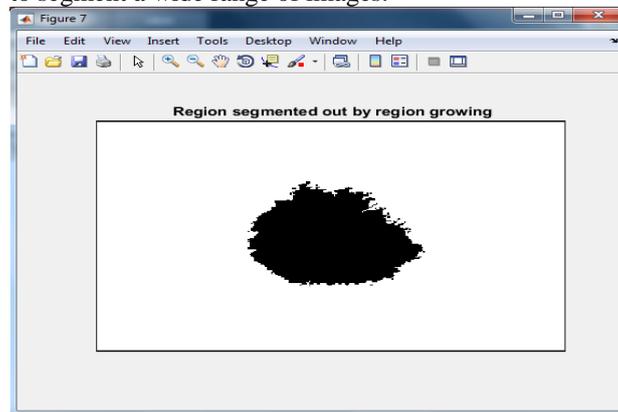


Fig 4.2: Melanoma image after region growing

V. EXPERIMENTAL RESULTS

Experimental results of proposed scheme have been discussed in this portion in which we used skin melanoma cancer images. We provided output results for different images in the last but resulted output at different points has been shown for only single image. Corresponding sensitivity and specificity of each image has been found using ground truth lesion pixels marked manually by the observer.

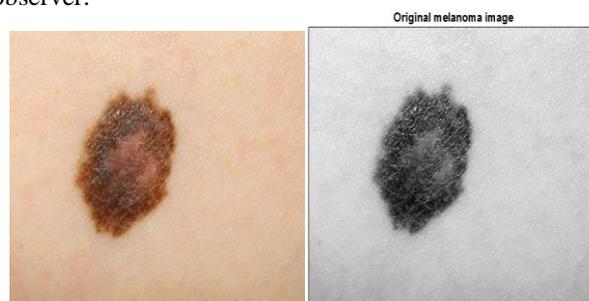


Figure 5.1: Image used for experimental results (a) Original Image (b) Gray scale image in MATLAB GUI

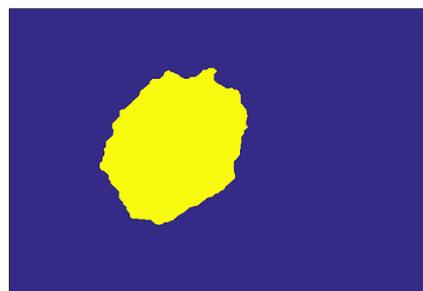


Figure 5.2: ground truth view of input image from observer's point of view.

1. False Negative:

A false negative arise when the test reports a negative result for a person who actually has the disease. The false negative rate is shown below:

$P(S+ | T-) = b/b+ d$. Which false result is the more deliberate depends on the situation. But we generally anguish more about false positives in screening tests. We don't want to tell anyone that they have a serious disease when they do not really have it.

Table 5.1: False negative and true positive values of Skin Cancer Images

Image no.	True positive	False negative
image 1	36456	2213
image2	2301	225
image3	91292	787
image4	8468	0
image5	23553	1021

Here in above table shows that false negatives value occurred less than true positive which is good indication that less people has serious disease.

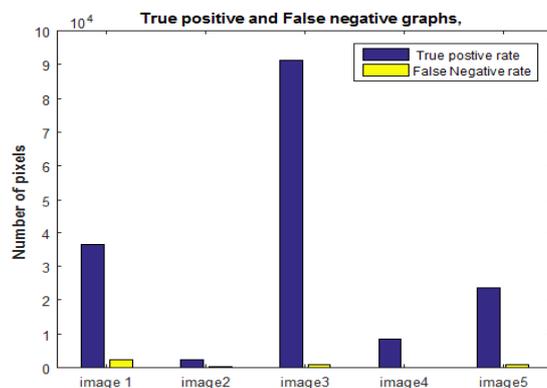


Figure 5.3: Graphs for true positive and false negative rates

From the results shown above it has been found that the proposed algorithm has high true positive rate. In most of the cases these value are above 90 %, which comes in excellent category of the results.

2. False Positive:

A false positive occurs when the test reports a positive result for a person who is disease free. The false positive rate is given by: $P(S- | T+) = c/c + a$. ideally we would like the value of c to be zero; however, this is generally impossible to achieve in a screening test involving a large population.

Table 5.2: False positive and true negative values of Skin Cancer Images

Image no.	True Negative	False positive
Image 1	254437	2157
Image 2	253139	395
Image 3	119488	3033
Image 4	109698	1684
Image 5	77215	211

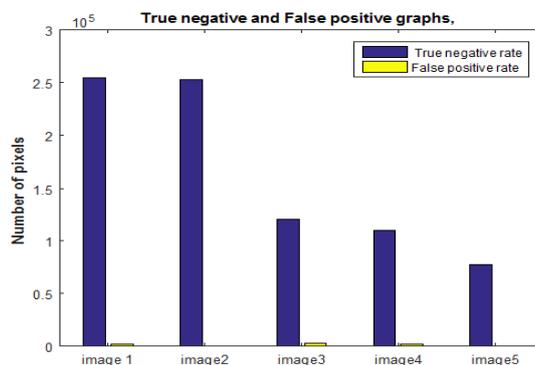


Figure 5.4: Graphs for true negative and false positive rates

From the results shown above it has been found that the proposed algorithm has low false positive values rather than true negative rate.

3. Sensitivity:

Sensitivity is a statistical measure that defines the proportion of true positive subjects with the disease in a total group of subjects with the disease (TP/TP+FN).

4. Specificity:

This measure of accuracy of a diagnostic test is complementary to sensitivity. It is defined as the proportion of subjects without the disease with negative test result to the total number of subjects without disease (TN/TN+FP).

Table 5.3: Respective value of Sensitivity and Specificity

Image no.	Sensitivity	Specificity
Image 1	0.9428	0.9916
Image 2	0.9109	0.998
Image 3	0.9915	0.9752
Image 4	1	0.9849
Image 5	0.9585	0.9973

Above table shows the respective sensitivity and specificity of randomly selected 5 images of melanoma from database of 75 lesions images. Based on the above comparative values of sensitivity and specificity table 1, the graph is generated as follows-

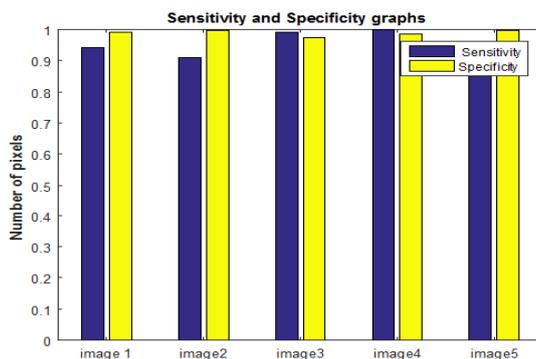


Figure 5.5: Bar graphs for sensitivity and specificity values

From the results shown above it has been found that the proposed algorithm has high sensitivity and specificity values. In most of the cases these value are above 90 %, which comes in excellent category of the results. We have provided results for few images as description but we tried the algorithm on number of images.

VI. CONCLUSION AND FUTURE SCOPE

The algorithm discussed presents fair level of detection of skin disorder vide the parameters as discussed in results table. The proposed algorithm shows better visual, segmentation, and classification results with a sensitivity of 99%, and specificity of 97%.

In future we will work on improving this algorithm differentiate melanoma images into number of verities. Improve the processing and analysis of skin images acquired with standard cameras. and we plan to further develop our approach by improving the lesion segmentation and classification stages, and test more extensively our method in clinical trials.

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