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Melanoma Detection Using RGB Color Model in Medical Imaging

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Abstract: Among existing skin tumors Melanomas are extremely harmful. This type of cancer increases rapidly. Melanoma can be identified through the attributes like color, regularity in the border, and symmetry. Here image processing methods and categorization methodologies are used to study melanoma of the skin. Color, asymmetry, diameter, and border are group of parameters having adequate information are used to distinguish melanoma by applying a series of transformations. In this model, color is considered as the key attribute to detect melanoma. To know the ideal color for separation of melanoma an automatic algorithm based on RGB color is proposed in this paper. This work reduces color image into an intensity to segment the image roughly by applying threshold value and morphological functions.

Key words: Skin segmentation · ABCD analysis · RGB color model · Threshold · Dermoscopy image · Melanoma detection

INTRODUCTION

Image segmentation being a major part of image processing derives significant information to trace and describe areas in a digital image. Skin detection is the method of choosing the pixels relevant to skin and plays a critical role in melanoma detection. Hani, K. Almohair proposed a methodology of identifying the skin beneath varying lightening situation [1]. Color based methodology for identifying skin is utilized over the number of applications in computer vision. [2]. Yang, proposes adaptive skin color methodology for identifying the face in real time [3]. This work aims to design automated melanoma detection. For the advancement of a computer assisted analysis of melanoma automatic segmentation of the skin cancer will be the basic step. Among available segmentation methods in melanoma application, few converge on identifying the skin based on highly distinguishing and good color space feature. Stools, recognized a diagnostic scheme for dermoscopy images known as the ABCD rule of dermoscopy [4]. Where, ABCD letters representing asymmetry, border regularity, diameter and color is used for classifying different types of tumors. The different letters represent the following criteria:

Asymmetry: Dermatologists suggest that the melanomas grow in a radical way during the kind of symmetric tumor.

Border Irregularity: Lesions present with clear confines when melanomas have irregular border contrast.

Color: Melanomas with number of colors allows describing the lesion using nearly six colors.

Diameter: Melanomas possess greater 6-7 mm of diameter.

Dermatologist carries out diagnosis visually and evaluates the melanoma quantitatively using ABCD rules. Henceforth the goal of this work is to classify automatically based on the ABCD features.

MATERIALS AND METHODS

The threshold operation among the region-based segmentation is efficiently used for the skin lesion segmentation problem [5]. Green imitated helpful separation of the lesions has found 171 out of 204 i.e., 83.8% precise separation [6]. G. Hance, *et al.*, compares six different color segmentation algorithms [7]. Y.W. Lim and S.U. Lee used fuzzy-c-means to segment color images [8].

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Average error obtained in a group of 66 test images using adaptive threshold is very low and about 40 were precisely separated. The effective combination of various methodologies has enhanced the classification by precisely locating the bounds and about 57 where accurately separated. M. Messadi, *et al.,* used image processing and categorization procedures for learning the skin melanoma [9]. Harald Ganster used computerized system for investigating the image derived as of ELM, which is the improved prior identification of harmful melanoma [10].

Data Description: Apply this model on literature images, shown in Figure 1.

Depending on the color space analysis a segmentation algorithm is developed in order to disclose the melanoma from the given dermatological images. The steps involved in the method are shown in Figure 2.

Color Space: These days RGB color space is widely used in image separation where the wavelength of green, blue and red colors present in orthogonal Cartesian space. The 3D vector's pixels spans between 0 and 255. High level processing using color methodology shows some drawbacks and in order to master these limitations other color spaces were established on the basis of transformations over original RGB color. In this model RGB Color space is used and details are shown in Table 1.

Color vector processing technique simultaneously processes every color component of the image. Generally the image with complete color has three compositions, often in vector form. Every point in RGB is seen as point with vector being originated from origin ina coordinate system. Let consider an RGB color area with arbitrary color vector c given as:

$$c = \begin{pmatrix} C_R \\ C_G \\ C_B \end{pmatrix} = \begin{pmatrix} R \\ G \\ B \end{pmatrix} - 1$$

The components in c give RGB consistency at the given point of the image . From Data Description defined in section 2.1 the following image, Figure 3, is taken for considerations.

Image Filtering: Eliminating the noises that are present in the image will considerably increase the accuracy of the segmentation result. Skin line or other random noises are the common effects that occur in the dermoscopy images due to the imaging process. To remove this effect, we smooth the skin image using an average low pass filter [11] and the following image Figure 4, is obtained.

Analysis of Color (Region of Interest / Sample Color Pixels)

By Region of Interest (ROI): In an RGB image, a group of sample color expressing the specific color is used to separate the particular color range. Using this sample color point, the objects are segmented. The process of getting a set of related color points in this way is called as Region of Interest (ROI).

A group of sample pixels expressing the melanoma color is chosen. Then the sample area is transformed into image having binary area where black and white is given by 0's and 1's as shown in Figure 5.

By Sample Color Pixels: A color image model which contains various melanoma skin pixels is designed. The color characteristics are determined by picking a group of sample pixels from every image given by different Dermoscopy images for clinical information. For every pixel in the samples of blue, red and green are computed. This methodology first needs a picture of a target image. The sample image shown in Figure 6 consists of the wide possibilities of different types of melanoma skin pixels appearing from the different countries and also in different colors. A mask image with white and black pattern is produced by detection algorithm. The values in the black pixels represent non-melanoma skin pixels and the white pixel values represent melanoma skin pixels. This mask of 1's and 0's appears like a logic binary map for detecting skin melanoma, using the RGB sample skin model.

Cluster Color Space Using Distance Metric and Threshold: In the given sample skin area, mean and covariance are computed. The mean gives an average pixel value of an image. For a grayscale image this is equal to the average brightness or intensity. Let the image f (x, y) be referred to using the shorthand f. The mean of this image, E (f), could be calculated using the Equation:

$$E[f] = \frac{1}{YX}\sum_{y=0}^{Y-1}\sum_{x=0}^{X-1} f(x, y) \quad (2)$$

Covariance

$$\text{cov}_{XY} = \frac{\sum XY}{n} - M_X M_Y \quad (3)$$

Therefore the Mean equals column vector m in RGB.

Every pixel in an RGB image with a given color range is categorized for image separation. Find threshold value. The standard deviation multiples of one color are used to set the initial value T The main diagonal of C contains the variety of the RGB components. To extract these elements

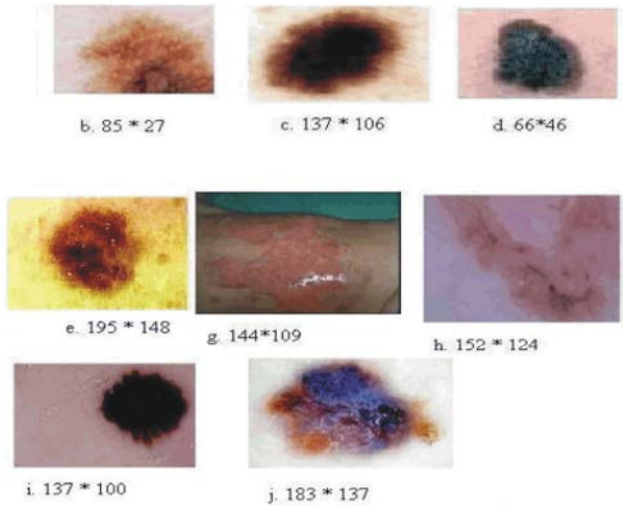


Fig. 1: Dermoscopy images taken for processing

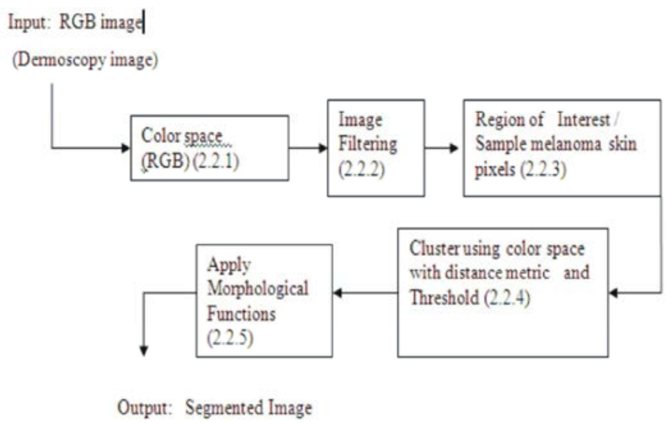


Fig. 2: Melanoma Detection Process

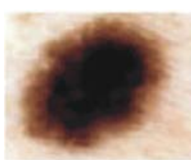
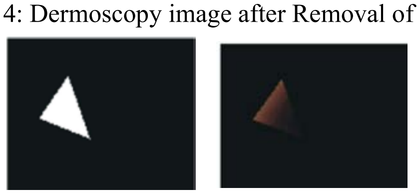


Fig. 3: Dermoscopy image for processing (RGB)

Fig. 4: Dermoscopy image after Removal of noise



Binary image RGB image

Fig. 5: Selected pixels By ROI

Table 1: 100% RGB color bars

	Normal range	White	Yellow	Cyan	Green	Magenta	Red	Blue	Black
R	0 to 255	255	255	0	0	255	255	0	0
G	0 to 255	255	255	255	255	0	0	0	0
B	0 to 255	255	0	255	0	255	0	255	0

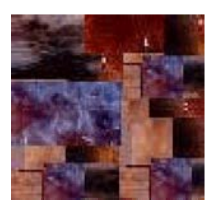


Fig. 6: Sample Image where pixels related to melanoma

and compute their square roots. The first element of the result is the standard deviation of the red component of the color pixels in the ROI and similar to the other two components. The image variance, var (f), gives an estimate of the spread of pixel values around the image mean. The standard deviation is sqrt (var (f)).

Fig. 7: Segmented results: By Sample pixel a, b ; By ROI c,d

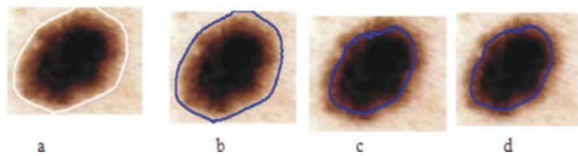


Fig. 8: Segmented images: By Sample Pixels a, b; By ROI c, d

$$\begin{aligned}\mathrm{Var}[\mathbf{f}] &= \mathrm{E}[\mathbf{f}^2] - \mathrm{E}[\mathbf{f}]^2 \\ &= \left(\frac{1}{YX}\sum_{y=0}^{Y-1}\sum_{x=0}^{X-1} f(x,y)^2\right) - \left(\frac{1}{YX}\sum_{y=0}^{Y-1}\sum_{x=0}^{X-1} f(x,y)\right)^2 \end{aligned} \quad (4)$$

Next segment the image using a value of T and apply Mahalanobis distance. Assuming z being a random point in RGB area where z is alike to m when the distance D (z, m) is considerably lower than the given threshold T. The distance of Mahalanobis is given as:

$$D_{ij} = \sqrt{(X_i - X_j)' S^{-1} (X_i - X_j)} \quad (5)$$

The S^{-1} represents the inverse of matrix covariance X. The X(i) and X(j) indicates corresponding rows i and j for estimating the distance between the row and the next X(i) and X(j) indicates the column i and j for estimating distance between column. The technique of categorizing the pixels of a gray scale images such that a binary image is obtained from the present image by giving the values 0 or 1 to each pixel is called as Threshold. Apply different threshold values, to obtain the melanoma skin region [1]. In the initial threshold, only less number of skin regions was segmented. For improved the result, double the threshold value and obtain the following image shown in Figure 7.

Morphological Functions: The purpose of applying morphology in binary image is to derive the components useful in expressing and defining the shape of image. Morphological algorithms are particularly useful in deriving the bounds, linked consistencies, convex hull and the area's outline. In our model, Boundary extraction and Region filling concepts are used to find the boundary in the detected images [12]. Applying this function the following results Figure 8, are obtained.

RESULTS AND DISCUSSION

The algorithm which we propose here has undergone a series of tests on a cluster of 40 dermoscopy images of high resolution. These dermoscopy images are of 24 bit of which each color channel consists of 8 bits. The proposed algorithm is implemented and a sample images are shown in the following Figures 9 & 10.

The Segmentation outcome is decided by matching the manual results with automated results. The comparison is done by counting the number of pixels in automated and manually detected results, which is shown

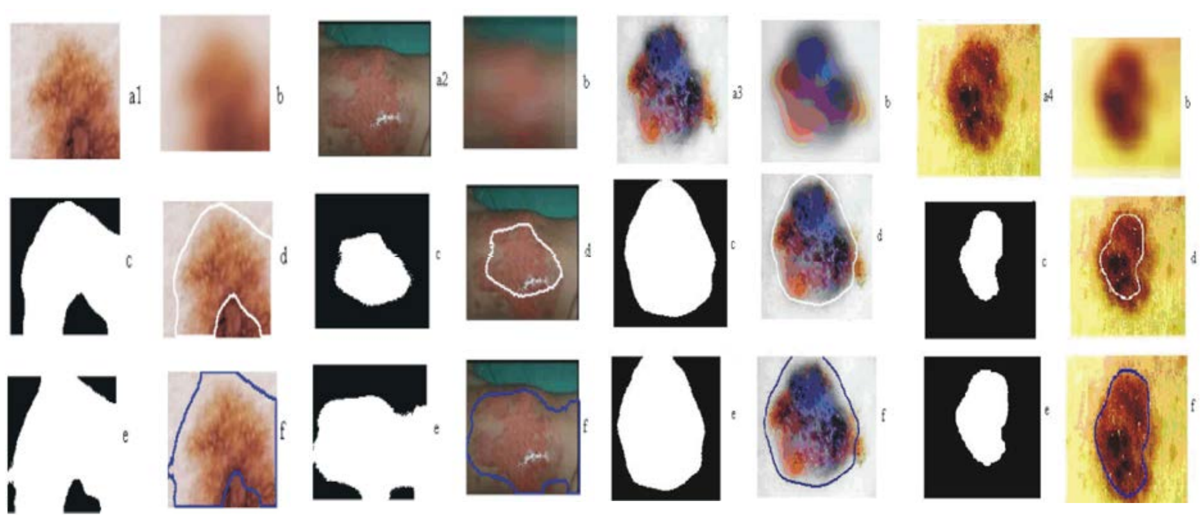


Fig. 9: Detected Images by Sample pixels
a1- Image 1 (85*24), a2 – Image 2 (144 *109), a3- Image 3 (183*137), a4-Image4 (195*148)

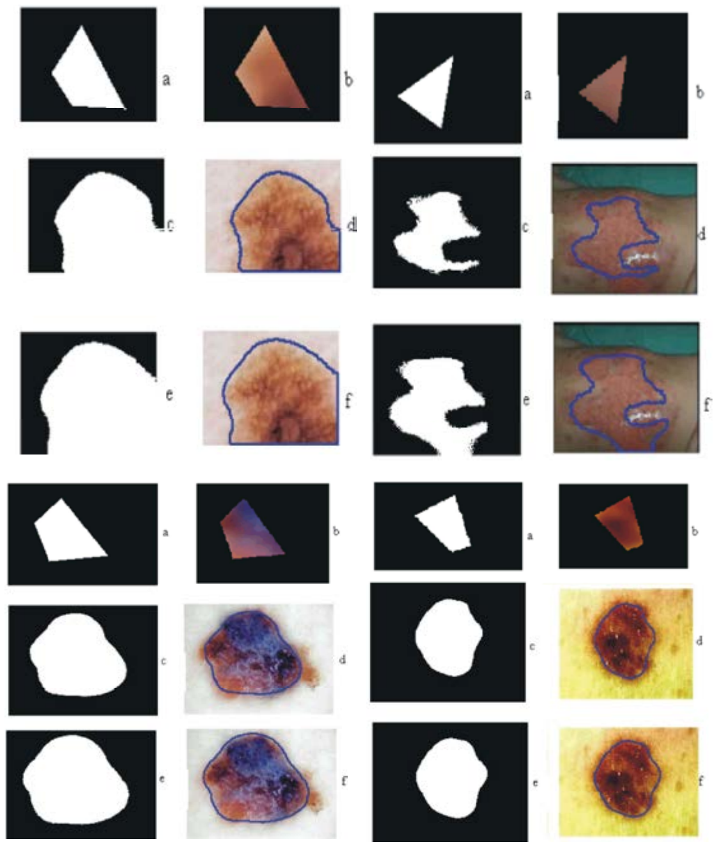


Fig. 10: Detected Images of a1, a2, a3 and a4 in fig. 9 By ROI
a – ROI Binary form, b – RGB form , c – single threshold, d- Detected image by single threshold, e – Multiple threshold, f – detected image by multiple threshold

Table 2: Experimental results

Image	Detected by Manual		Number of pixels Detected Using		Error Rate for column	
	Skin image	No. Of pixels	ROI	Sample image	(2)	(3)
Image 1 (a1)		6476	(T1-5425, T2-6375)	(T1-6027, T2-6287)	12%	13%
Image 2 (a2)		5859	(T1-3225, T2-4850)	(T1-4006, T2-9726)	18%	32%
Image 3 (a3)		11453	(T1-8924, T2-10620)	(T1-6479, T2-9408)	4%	18%
Image 4 (a4)		6089	(T1-5754, T2=6001)	(T1-3799, T2-5900)	2%	4%

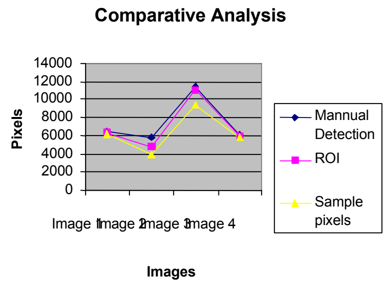


Fig. 11: Comparison chart

in Table 2 and Figure 11. The proposed method is faster and provided better results. To achieve the maximum performance with a precision of approximately 98% (BY ROI) and 96% (By Sample method). Even then, some false detection also occurs. When compared with the two models (By ROI & Sample model) some of the images (Table 2: Image2 - a2), the nearest results are obtained in the single threshold itself by sample pixel models, but not in an accurate manner. In multiple threshold non-melanoma pixels were detected. Among the 40 tested dermoscopy images the melanoma pixels identified using RGB color shows overall performance, greater than 90% under Region of Interest method.

CONCLUSIONS

This paper proposes an automatic algorithm for precise segmentation that depends on the RGB color space analysis for finding out the melanoma in dermoscopy images. It undergoes various processing steps, such as filtering the image, Analysis of Color (Region of Sample Color Pixels) and Morphological Functions to detect the defected areas. The process undergoes in two different methods ROI and using sample pixels. From the experimental results shown in Table 2; better detection rate is obtained by a Region of Interest method. Minimum 82 % to Maximum 98 % of skin melanoma is detected.

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