Advanced Earlier Melanoma Detection Algorithm Using Colour Correlogram

SOUMYA R S*[1], NEETHU S*[2], NIJU T S*[3], RENJINI A[$], ANEESH R. P[#.]
*P G Scholar, Rajadhani Institute of Engineering and Technology, Trivandrum
[1]soumyars19@gmail.com, [2]neethus14@gmail.com, [3]nijuvikraman@gmail.com
$ Assistant Professor, Rajadhani Institute of Engineering and Technology, renjinia@rietedu.in,
#Regional centre IHRD, Trivandrum, India, aneeshprakkulam@gmail.com

***Abstract*- Melanoma is a most dangerous form of skin cancer that develops from the pigment producing cells known as melanocytes. Melanoma skin cancers are also known as malignant melanoma. Recent studies show that the death rates of melanoma patients depend on the various stages of cancer, so early detection and treatment of melanoma implicate higher chances of cure. Now most of the existing skin lesion analysis system use ABCDE parameters for feature extraction. But these methods have lot of drawbacks. In this paper an advance earlier melanoma detection algorithm is proposed using colour correlogram and texture analysis. Bayesian classifier is used to detect the abnormal skin cells with colour correlogram and SFTA feature vectors. The system is successfully tested with the dermoscopic dataset and the experimental results show that the combination of colour correlogram and texture analysis give better results with an accuracy of 91.5%.**

***Index Terms*- Skin Cancer, Melanoma, Image segmentation, Colour correlogram, SFTA, Bayesian classifier.**

I. INTRODUCTION

Nowadays melanoma skin cancer has been increasingly identified as the major cause of deaths. It is a condition or a disorder that develops from the melanocytes, which produce a pigment known as melanin**.** So melanoma regions appear as black or brown in colour. But some of them doesn't produce melanin; they appear as pink, tan or white colour. Compared to all other skin cancers like Basal Cell Carcinoma (BCC) and Squamous Cell Carcinomas (SCC), the malignant melanomas are the most dangerous form. Since it can easily affect the other parts of the body. Normally these malignant melanoma begins on the skin surface where it is easy to see and treat. Then it grows deep in to the skin and reaches at the blood vessels. Finally, it will spread to other parts of the body and affect various organs.

Melanoma skin cancers have different stages which are Stage 0, Stage I, Stage II, and Stage III [1]. In Stage 0, tumours will not penetrate below the surface of skin. In Stage I, tumours invade the skin but are unulcerated and grow at a slow mitotic rate. Stage II is considered as intermediate melanoma and have different classifications. In Stage IIA, tumour is 1-2mm thick, in Stage IIB, it is 2-4mm thick and in Stage IIC, the thickness is above 4 mm. Stage III is the most advanced stage of melanoma which affects various organs and the treatment becomes difficult. So early detection of melanoma is very essential. The proposed system provides the possibility of early detection of melanoma with better accuracy using colour correlogram and texture analysis.

In the case of melanoma, the characteristics are summarized by 'ABCDE' parameters [2]. To detect melanoma skin cancer, most of the existing methods extract the features like Asymmetry, Border, Colour and Diameter. But the calculation process of these features are complex and are not much efficient. From these five parameters, colour variation is the most powerful factor. In the existing method colour is extracted by using colour histogram. Here images are scanned in one pass and the number of pixels were calculated corresponding to each intensity value. But it doesn't contain any spatial information. In this proposed paper, colour correlogram method is introduced to compute colour correlation. Histogram of two images may be same but the correlogram may not be same. The colour correlogram gives information about the spatial correlation of colour variation with distance. A texture analysis method is also proposed with colour correlogram. Texture features are used to analyse the repetitive patterns in the segmented lesion.

II. PROPOSED METHOD

The main components of the proposed system are Image acquisition, Hair detection and removal, Active contour based segmentation, Feature extraction using colour correlogram and texture and

Bayesian classifier for classification. The block diagram for the proposed system is shown below.

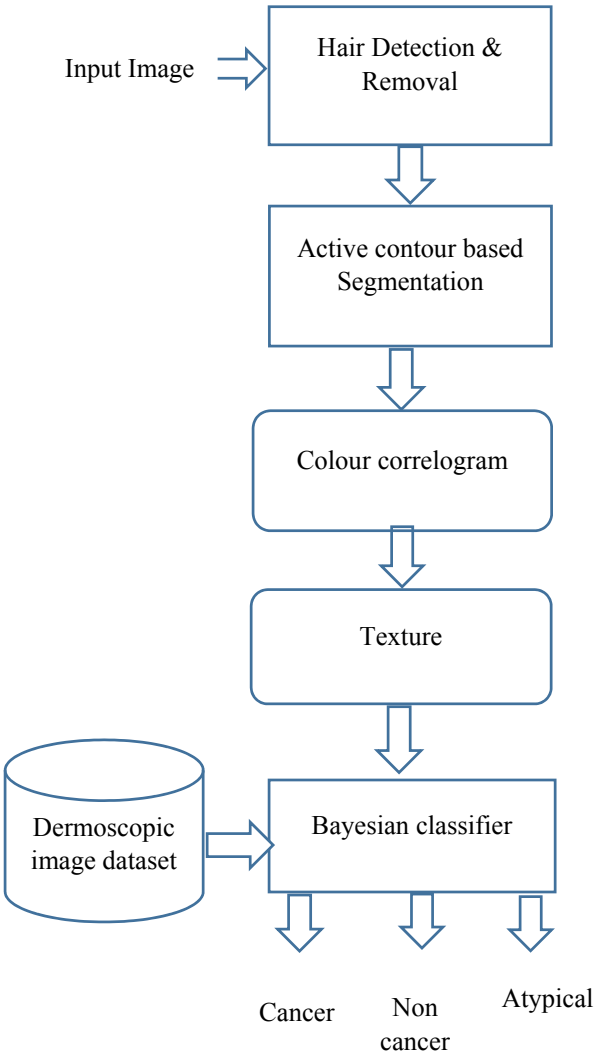

Figure 1. Block diagram for the proposed system

A. *Image Acquisition*

Image acquisition is the preliminary stage of all image processing systems. The proper way of data acquisition is very essential for an accurate final result. In this skin lesion analysis system, dermoscopes are used to obtain images. Dermoscope is a battery powered hand held device with a high quality magnifying lens used for examining pigmented lesion. This method is known as dermoscopy or dermetoscopy [3]. Due to the presence of optical system with several lenses, the dermoscope has an ability to provide right standardised zoom with autofocus. To improve the picture quality, it has a unique twin light system with 6 polarised white LED. The iPhone can also be used for capturing image. But it can't provide satisfactory results because when the distance between the camera and skin changes, the size of the captured lesion varies. The environment light condition also affects the quality of image, so dermoscopy is the best way to achieve high quality image.

B. *Pre-Processing*

Pre-processing is the first step of any image processing technique. Hair detection and removal of dermoscopic image is focused here [4] - [7]. The presence of hair obstructs the segmentation and feature extraction. It may affect the classification results also. So a proper method is needed to reconstruct the dermoscopic images without any hair. Figure 2 shows a sample image captured using dermoscope.

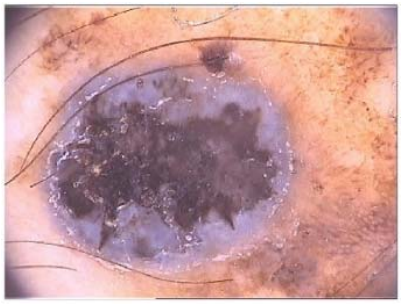

Figure 2. Dermoscopic image with hair

Here 84 directional filters are applied to the original input image. Then a hair mask is created which is very helpful to find out the position of hair. Figure 3 shows the hair mask of figure 2.

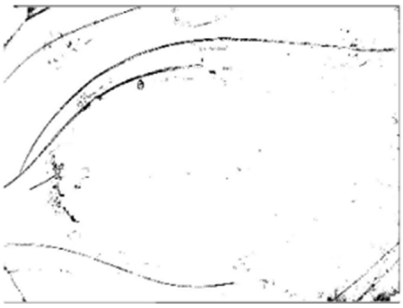

Figure 3. Hair mask

To reconstruct the original image, first of all the system select the adjacent edge pixels in 8 direction considering the actual pixel inside the region to be filled [8]. Now find out the maximum value of these 8 edge pixels and replace the hair pixels with this maximum pixel value. Figure 4 shows a reconstructed dermoscopic image.

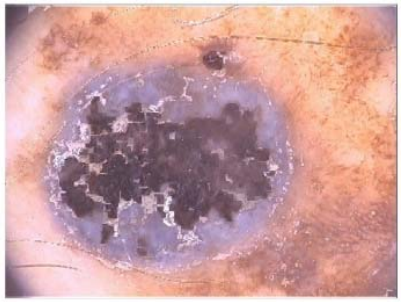

Figure 4. Reconstructed image without hair

C. Image Segmentation

Image segmentation is the process of separating lesion region from the background [10]. This step is very useful for proper feature extraction. In this paper active contour based segmentation is applied to obtain satisfactory results [9]. To perform active contour based segmentation, a mask is needed to specify the initial location of the active contour. So first stage of image segmentation is the creation of mask. The segmentation steps are detailed below.

At first dermoscopic image is converted to its corresponding gray scale image. After that the image is filtered. To achieve this, a gaussian LPF is generated using the equations 1and 2. [11]

$$h_g(n_1, n_2) = e^{-(n_1^2+n_2^2)/2\sigma^2} \quad (1)$$

$$h(n_1, n_2) = h_g(n_1, n_2) / \sum_{n1}\sum_{n2} h_g \quad (2)$$

where sigma is 0.5 and h is a 2D filter of size n_1, n_2

Then Otsu's method is applied to the filtered image to compute the global threshold value to minimize the variance of foreground and background pixels in a class [12]. It can perform clustering based image thresholding and thus convert to binary image. After thresholding, image contains some black corners. These black corners are replaced with white pixels using disk shaped mask [13]. Now the edge of the resultant image becomes irregular. To remove the irregularities of the edges of the resultant image, morphological operations are applied. Then a mask is obtained to initialize the location of the active contour and it is applied to the gray scale image. now the image is segmented into foreground and background region using active contour based segmentation. This algorithm uses the Sparse-Field level-set method for implementing active contour evolution and it also stops the evolution of the active contour when the maximum number of iterations (i.e. 400) has been reached or if the contour position in the current iteration is the same as one of the contour positions from the most recent five iterations.

After applying active contour, the resultant binary image may contain some small object having size less than 50 pixels. In order to remove such small objects, area opening operations are applied. Then morphological operations are performed and a final binary mask is obtained which is applied to the reconstructed RGB image and the pigmented lesion is separated from the background.

D. Feature Extraction

Feature extraction is a very important stage because it has a direct influence on the classification results. In this study, features of the segmented lesions are computed by using colour correlogram and texture analysis.

a) Colour correlogram

In spatial data analysis, correlogram is an image of correlation statistics. The results of spatial data analysis depend on the location of the object being analysed. Colour correlogram vector indicates colour correlation of neighbourhood pixels in the indexed image. Here a user defined distance vector is present, which indicates the different distances from which the colour distribution is calculated. In colour correlogram, feature vectors of each image database is computed and values are stored as their colour image [14]. Then the vector value of tested images is calculated and compared with the feature vectors of trained images. In this paper correlogram with small distance value is selected to reduce computational cost.

The correlogram stores the index value of pairs of colours (i, j) in a table, where i and j are two pixels at a distance d and the d^{th} entry shows the probability of finding j from i. Let [D] denote a set of D fixed distances {d1,….dD} Then the correlogram, $\gamma^{d}_{ci,cj}(I)$ of the image I is defined for colour pair (ci,cj) at a distance d is,

$$\gamma^{d}_{ci,cj}(I) = p1 \in I\, ci\, P_{r\, p2 \in I\, [p2 \in Icj \,\|\, p1-p2\| = d]} \quad (3)$$

The auto correlation is the spatial correlation between two similar colours. Auto correlogram of image, I is represented by

$$\alpha^{d}_{ci,cj}(I) = \gamma^{d}_{ci,cj}(I) \quad (4)$$

b) Texture

In this paper Segmentation based Fractal Texture Analysis (SFTA) method is used for extracting texture feature. In SFTA the fractal dimensions of the segmented region are calculated and then describe the texture patterns of that region [15]. The fractal dimension gives an idea about the boundary

complexity and structure. Suppose the binary image is I_b (x,y) then the border image,

$$\Delta(x,y) = \begin{cases} 1, & if\ \exists(x',y') \in N8[(x,y)] \\ & Ib(x',y') = 0 \\ & Ib(x,y) = 1 \\ 0. & Otherwise \end{cases} \quad (5)$$

E. Classification

Bayesian classifier is applied to achieve efficient classification for large data sets. It is very useful for statistical classification. The basic idea of a Bayesian classifier is that it assumes any one feature of a classifier is that it is not related to any of another feature. Here the system classifies images into melanoma, non-cancer and atypical on the basis of extracted features. Working of Bayesian classifier is based on Bayes' theorem. According to Baye's theorem posterior probability can found which is given by the equation

$$\text{Posterior probability, } P(c/x) = \frac{p(x/c)p(c)}{p(x)} \quad (6)$$

where p(x) is prior probability of predictor, p(c) is predictor probability of class and p(x/c) is the likelihood which is the probability of predictor given class.

III. RESULTS

In this proposed system, PH^2 dermoscopic image database from Pedro Hispano Hospital is used for the experiment [16]. The database contains 200 RGB colour image.

The lesion region is segmented by using active contour based segmentation and their colour features are calculated by colour correlogram and texture features are extracted by using SFTA. Different approaches are applied for both segmentation and feature extraction. Finally select active contour for segmentation and the combination of colour correlogram and SFTA for feature extraction. The segmentation results are shown in figure 5.

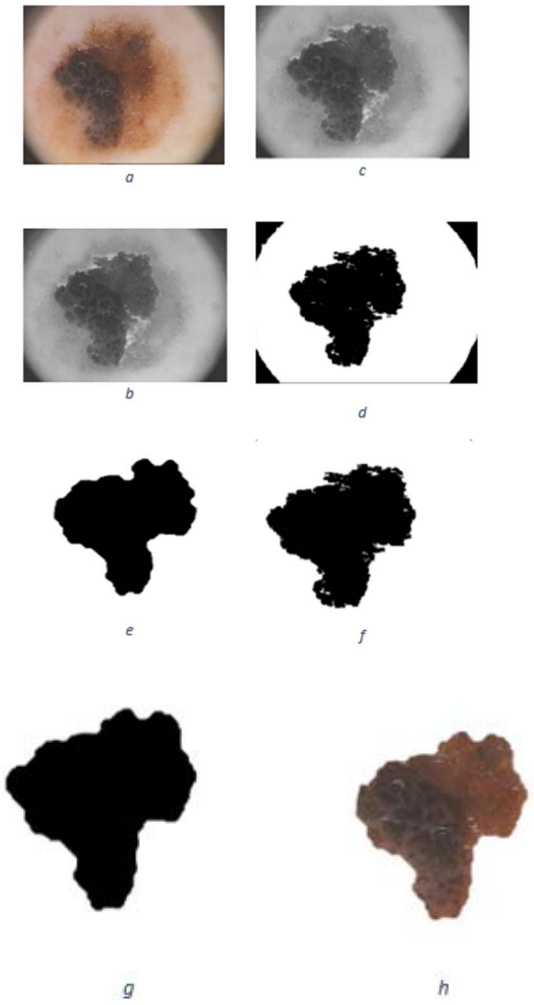

Figure 5: a. Dermoscopic image, b. Gray scale image c. filtering, d. Thresholding, e. Mask for active contour, f. Active contour, g. Final binary Mask, h. Segmented lesion

Tables 1, 2 and 3 shows the confusion matrices of melanoma, atypical and non-cancer respectively. From the 200 PH^2 dermoscopic image database, 40 images were correctly identified as melanoma, 70 were identified as atypical and 73 were identified as non-cancer by using Bayesian classifier thus providing an excellent accuracy of 91.5%.

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} \quad (7)$$

TABLE 1: CONFUSION MATRIX OF MELANOMA

	TP	TN	FP	FN
Melanoma	40	143	2	15

Accuracy = 91.5%

TABLE 2: CONFUSION MATRIX OF ATYPICAL

	TP	TN	FP	FN
Atypical	70	113	5	12

Accuracy = 91.5%

TABLE 3: CONFUSION MATRIX OF NON CANCER

	TP	TN	FP	FN
Non cancer	73	110	11	6

Accuracy = 91.5%

IV. CONCLUSION AND FUTURE SCOPE

This paper presents a new method for detecting melanoma skin cancer by analysing colour variation using colour correlogram. The highlight of this proposed method is that there is no need of analysing ABCDE parameters which makes the analysis much complex. By using the combination of colour correlogram and texture, these problems can overcome and thus it is most suitable for the efficient detection of melanoma, atypical and normal moles in early stages. The early detection of melanoma skin cancer and atypical moles will help us to provide timely and effective treatment.

The algorithm for segmentation can be modified to detect the skin lesion images with different illumination conditions. This work can be implement as a real time mobile application.

REFERENCES

[1] O. Abuzaghleh, B. D. Barkana, and M. Faezipour, "SKINcure: A real time image analysis system to aid in the malignant melanoma prevention and early detection," in Proc. IEEE Southwest Symp. Image Anal. Interpretation (SSIAI), Apr. 2014, pp. 85_88.

[2] M. Rademaker and A. Oakley, "Digital monitoring by whole body photography and sequential digital dermoscopy detects thinner melanomas," J. Primary Health Care, vol. 2, no. 4, pp. 268_272, 2010

[3] Abuzaghleh Omar, Barkana D Buket, "Noninvasive Real-Time Automated Skin Lesion Analysis system for Melanoma Early Detection and Prevention" IEEE Trans. Eng. Health and Medicine. Vol. 3, 2015

[4] H. Zhou et al., ''Feature-preserving artifact removal from dermoscopy images,'' Proc. SPIE, vol. 6914, p. 69141B, Mar. 2008.

[5] Q. Abbas, I.F.Garcia, M.E.Celebi, and W.Ahmad,''Afeature-preserving hair removal algorithm for dermoscopy images,'' Skin Res. Technol., vol. 19, no. 1, pp. e27–e36, 2013

[6] F.-Y. Xie, S.-Y. Qin, Z.-G. Jiang, and R.-S. Meng, ''PDE-based unsupervised repair of hair-occluded information in dermoscopy images of melanoma,'' Comput. Med. Imag. Graph., vol. 33, no. 4, pp. 275–282, 2009.

[7] H.Nguyen, T.K.Lee, and M.S.Atkins, ''Segmentation of light and dark hair in dermoscopic images: A hybrid approach using a universal kernel,'' Proc. SPIE, vol. 7623, p. 76234N, Mar. 2010

[8] C. Barata, J. S. Marques, and J. Rozeira, ''A system for the detection of pigment network in dermoscopy images using directional filters,'' IEEE Trans. Biomed. Eng., vol. 59, no. 10, pp. 2744–2754, Oct. 2012.

[9] M. Silveira et al., ''Comparison of segmentation methods for melanoma diagnosis in dermoscopy images,'' IEEE J. Sel. Topics Signal Process., vol. 3, no. 1, pp. 35–45, Feb. 2009

[10] M. E. Celebi et al., ''Fast and accurate border detection in dermoscopy images using statistical region merging,'' Proc. SPIE, vol. 6512, pp. 65123V-1–65123V-10,Mar.2007.

[11] K. Ito and K. Xiong, ''Gaussian filters for nonlinear filtering problems,'' IEEE Trans. Autom. Control, vol. 45, no. 5, pp. 910–927, May 2000

[12] N. Otsu, ''A threshold selection method from gray-level histograms,'' Automatica, vol. 11, nos. 285–296, pp. 23–27, 1975.

[13] R. Adams, ''Radial decomposition of disks and spheres,'' CVGIP, Graph. Models Image Process., vol. 55, no. 5, pp. 325–332, 1993

[14] Hazra Dipankar, '' Retrieval of Color Image using Color Correlogram and Wavelet Filters'', Proc. of Int. Conf. on Advances in Computer Engineering 2011

[15] C. Traina Jr., A. J. M. Traina, L.Wu, and C . Faloutsos, "Fast feature selection using fractal dimension," in Brazilian Symposium on Databases (SBBD), João Pessoa, Brazil, 2000, pp. 158–171

[16] www.fc.up.pt/addi/ph2%20database.html