Detection of Melanoma Skin Cancer using Segmentation and Classification Algorithm

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***Abstract* - *M*elanoma is the most dangerous skin cancer. It should be diagnosed early because of its aggressiveness. To diagnose melanoma earlier, skin lesion should be segmented accurately. To reduce the cost for specialists to screen every patient, there is a need of automated melanoma prescreening system to diagnose melanoma using images acquired in digital cameras. In this frame work, an automated melanoma prescreening system is proposed to diagnose melanoma skin cancer using modified tdls algorithm and svm classifier. Representative texture distributions are obtained from texture vectors. The segmentation accuracy is improved by modification in tdls algorithm. Td metric is calculated with lesion texture distributions only. The entire system is tested using matlab software.**

Keywords: Melanoma, skin lesion, TDLS, SVM, Dermatoscope

1. INTRODUCTION

Generally there are three types of skin cancer: Basal cell carcinoma, Squamous cell carcinoma and Melanoma. Melanoma is a malignant tumour of melanocytes, it is composed of melanin cells which gives color to the skin. Melanoma skin lesions are having unique symptoms like asymmetric structure i.e., one half is not equal to other half, irregular border, different colors like pink, red and brown where normal skin lesions have black color lesions and diameter is more than 6mm[1]. UV radiations and tanning beds are causes of melanoma skin cancer. It cannot be curable if it is not detected early. Non-Hispanic white people in the United States in 2013 are mostly affected due to this skin cancer. If it is detected earlier, then life time can be increased. Otherwise it decreases the life span [1]. In earlier dermatologists used dermatoscope to acquire skin lesion images. It is a special device which is used by dermatologists to acquire skin lesion images; it acts as a magnifier and filter. The images acquired through dermatoscope are referred as dermoscopy images. These images may have low noise and good background illumination. Due to insufficient training to use the device standard digital camera is used in this framework. The dermatologists have risk to screen every patient. The existing system uses an automated prescreening algorithm for detecting melanoma skin cancer. In this frame work, the standard digital camera is used to acquire skin lesion images. It reduces the cost of screening melanoma skin cancer. Due to this non-specialists and practitioners can also analyze the skin lesion images.

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To classify the lesion as benign or malignant, features of lesion are extracted. Before that, it is important that to find the location of lesion border, this is achieved using a segmentation algorithm. The main aim of image segmentation process is to partition the image into many regions, to locate the objects into the image for particular applications like image processing and pattern recognition. Skin lesions are abnormal growth of the skin. Benign skin lesions can be easily diagnosed; they are not harmful to patients. Malignant skin lesions like nevi are very harmful to patients, they cannot be easily diagnosed. To extract the features, it is important to estimate the accurate lesion border which is used for classification.

There is a common set of features used for classification of skin lesion called ABCD scale: Asymmetry, Border irregularity, Color variation and Diameter [1].The border irregularity depends on the accurate estimate of the lesion border. Due to this feature, it is very important to locate the skin lesion accurately in digital images.Fig.1 shows the example of melanoma skin lesion image.

Fig. 1. Melanoma skin lesion image

There are many segmentation algorithms to segment the skin lesions from digital images automatically. Most of the existing algorithms are suitable only for dermoscopy images. It is hard to segment the skin lesion from digital photograph due to illumination variation. Segmentation algorithms can misunderstand the shadows as skin lesions if preprocessing is not done. Illumination correction is very important for complex texture pattern skin[2]. Skin lesion and normal skin areas have different textures. Texture represents spatial arrangement of pixel intensities or color, smoothness and hardness. Segmentation algorithms for skin lesion images are based on color and texture.

This paper describes an efficient melanoma prescreening system for standard digital camera images and texture based segmentation algorithm to improve segmentation accuracy which uses textural distinctiveness metric, which allows non-specialists can also analyze such images.

The rest of this paper is organized as follows. Section2 discusses about the related work of this paper.Section3 describes about the proposed work which includes preprocessing (MSIM algorithm), skin lesion segmentation, feature extraction and skin lesion classification. Section 4 shows the experimental and Section5 describes about the conclusion and future work of this proposed work.

2. RELATED WORK

Segmentation algorithms for dermoscopy images or skin lesion photographs use texture information. Existing segmentation algorithm (Otsu-RGB) for standard digital camera images proposed by Cavalcanti [6] used three channels for thresholding. Shadings are removed using morphological operations .To segment the skin lesion local textural variability information, principal component analysis are used. The results of [6] have been proven that Otsu-RGB algorithm has reduced segmentation errors, but this algorithm has low segmentation accuracy.

Texture based segmentation algorithms have been proposed for dermoscopy images which uses first order-region statistics [7].In this paper thresholding, region based and edge based segmentation algorithms have been implemented and compared. It have been proven that these algorithms provide good segmentation results, but these algorithms are not suitable for skin lesion photographs due to illumination variation.

In texture based segmentation texture distinctiveness map is calculated to find salient region detection [4]. In this paper texture distinctiveness algorithm has been implemented, it describes the salient region detection which is based on pixel intensity variation, color and texture. Texture representation is based on rotational-invariant neighborhood pixels. Pixels are clustered using k-means algorithm. The results of [4] reveals that TD algorithm provide better salient region detection, but does not use statistical information.

In k-means clustering algorithm pixels are grouped based on their pixel intensity similarity. This algorithm is easy to implement [5]. Texture distributions are obtained for each pixel. Representative texture distributions are calculated. To improve segmentation accuracy TD metric is calculated which finds dissimilarity between two texture distributions [1].

In existing texture based segmentation algorithms there is a problem to segment the lesion accurately, some of them suitable for dermoscopy images only .So the main contribution of this frame work is to improve segmentation accuracy than existing algorithms and adapt the segmentation algorithm to skin lesion photographs

3. PROPOSED WORK

The Fig.2 shows the proposed work of this paper which is explained in the following sections.

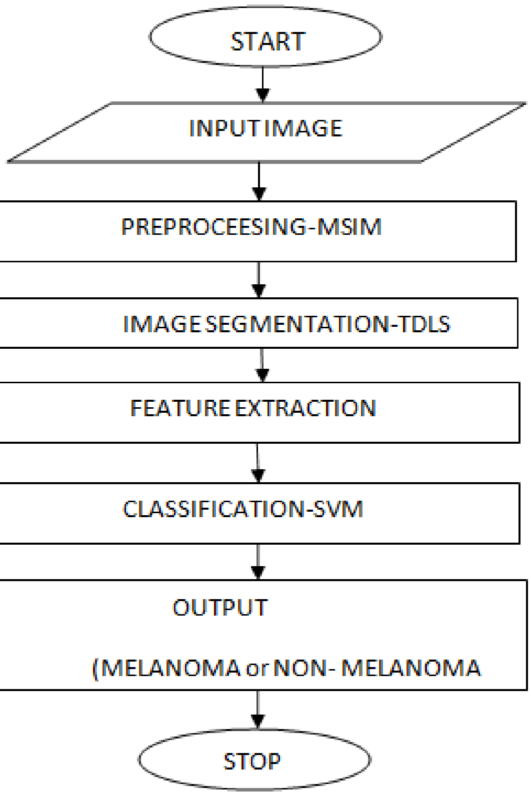

Fig.2. Work flow of proposed system

3.1. Preprocessing

Preprocessing is very important step in segmentation of skin lesions from digital images. In this proposed work standard digital camera is used to capture skin lesion images. Illumination variation occurs due to shadows, this feature allows misclassification of the shadows as skin lesion . In this paper Multistage Illumination Modeling algorithm (MSIM) [3] is implemented to remove illumination variation.

3.1.1. MSIM algorithm

The main advantage of MSIM algorithm is: It has the following special features than existing algorithms..

- It can be used for complex texture images
- It maintains consistent skin lesion color after removing shadows i.e. skin lesion color does not vary.
- It provides good illumination correction.
- It avoids misclassification of skin lesion.

MSIM algorithm involves three steps:

1. Segmentation map

2. Illumination map
3. Reflectance map

3.1.1.1 Segmentation map

To classify the pixels as normal or lesion statistical region merging algorithm (SRM) is implemented.

3.1.1.1. A. Statistical Region Merging Algorithm

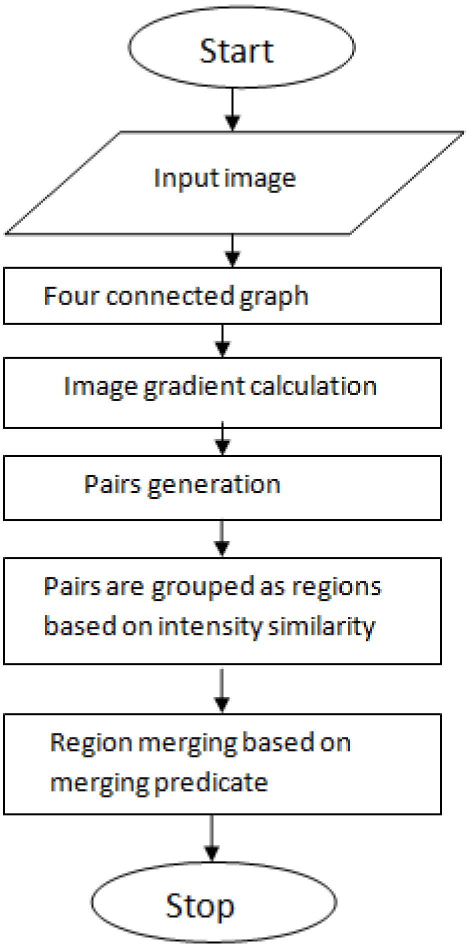

Fig.3 Work flow of SRM algorithm

Fig.3 shows the work flow of Statistical Region Merging algorithm which is explained in the following section.

3.1.1.1. (B). Algorithm steps

Step1: Start the process.

Step2: Get the input skin lesion image.

Step3: Construct four connected graph using horizontal and vertical pixels.

Step4: Calculate image gradient to find edge pixels. Image gradient provides the information about pixel intensity variation in horizontal and vertical direction.

Step5: Generate pairs using four connectivity graphs.

Step6: Group the pairs as regions based on pixel intensity similarity.

Step7: Combine regions based on merging predicate using the equation (1),(2)&(3).

P (R, R′) = $\overline{|R'_a - R_a|} \le \sqrt{b^2(R) + b^2(R')}$ -- (1)

b (R, R′) = $\sqrt{b^2(R) + b^2(R')}$ -- (2)

b(R)= $g\sqrt{1/2Q|R|\ln|K_{|R|}|/\delta}$ --(3)

Where R'_a and R_a are observed average pixel intensities in the regions R' and R respectively , b (R,R′) is merging threshold, P(R,R′) is merging predicate which combines two regions(R,R′) of the image, g is maximum pixel intensity, Q is defined as segmentation parameter which decides the number of regions to be segmented in the image I. If K is set of regions with l pixels,δ is defined as $1/6|I|^2$.

Step8: Stop the process.

3.1.1.2. Illumination map

After classifying the pixels as skin lesion or normal skin the original RGB image is converted into HSV colour space to get illumination map. Skin lesion photograph is illuminated through white light. Due to this only V channel is downscaled. Hue and saturation channels are not used.

3.1.1.3. Reflectance map

To get final illumination corrected image reflectance map should be estimated, it is obtained from V channel pixel intensity and illumination map. Finally hue and saturation channels are added to value channel to corrected image.

v(s) =i(s).r(s)

Where s is pixel location, v(s) is V channel pixel intensity, i(s) is illumination component, r(s) is reflectance component.

3.2. Segmentation

In this paper Modified Texture Distinctiveness lesion segmentation algorithm (M-TDLS) is proposed to segment the skin lesion. M-TDLS algorithm involves two steps.

1. TD metric Calculation
2. Region Classification

3.2.1. TD Metric Calculation

Original RGB image is converted to XYZ colour space, which gives efficient skin lesion detection. Texture vectors are extracted for each pixel to find representative texture distributions [4], probability of distinctiveness between two texture distributions is calculated.

TD metric is calculated to find dissimilarity between two texture distributions. Skin lesion distributions have high TD metric due to having high pixel intensity variation, where normal skin distributions are same.TD metric is based on only lesion texture distributions.

3.2.2. Region Classification

The second step is to oversegment the input image to classify the regions as normal or lesion. Otsu threshold value is used to divide the set of texture distributions into two classes, which classifies texture distributions belongs to normal or lesion. Region Distinctiveness metric is used for region classification which is based on TD metric. After classification morphological dilation operator is used to refine the lesion border which provides accurate estimate of lesion border.

3.3. Feature extraction

After segmenting the skin lesion, to classify it as melanoma or non-melanoma some unique feature is extracted, these features are given as input to the classifier. Unique features of melanoma are asymmetry, border irregularity, colour variation and diameter.

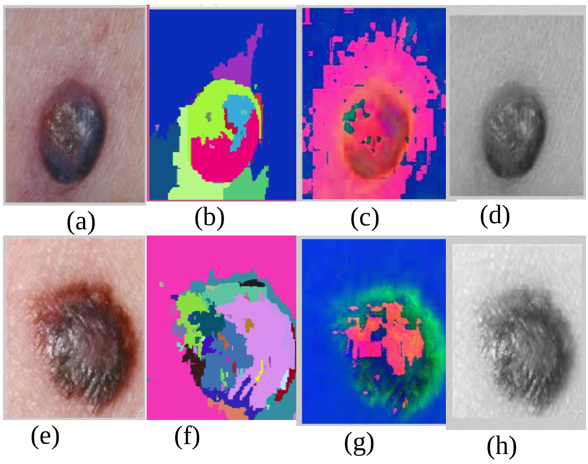

Fig.4.Segmentation and Illumination map

To find asymmetry of lesion solidity, equivalent diameter features are calculated, for Border irregularity mean and variance are calculated. To determine colour variation maximum and minimum pixel intensities of RGB channels are calculated.

3.4. Classification

There are many classification algorithms to classify segmented lesion image like ANN classifier, hybrid classifier, SVM classifier, In this paper Support Vector Machine (SVM) classifier algorithm is used to classify the segmented lesion as melanoma or non-melanoma. SVM classifier [2] provides good classification results in image processing. SVM constructs hyper planes to classify a set of data.

4. RESULTS AND DISCUSSIONS

In this paper Statistical Region Merging algorithm have been tested for different input skin lesion images. The pixels in the image are classified as lesion or normal skin [8].

In Fig.4.(a)and(e) reveal the original images of skin lesions , (b)and(f) show segmentation maps which is used to classify the pixels as belongs to normal skin or lesion ,(c)and(g) show HSV images of input images to get V channel,(d)and(h) shows down sampled images to get illumination map.

From the results in fig.4 it is observed that segmentation map and illumination map are obtained which can be used to get reflectance map to remove illumination variation. Here, original RGB image is converted to HSV colour space because the skin lesion in the photograph is illuminated through white light only. So V channel is used to remove illumination variation.

Based on the segmentation parameter Q, the regions of image can be segmented. As the Q factor increases, the number of regions can also be increased and vice versa. In this frame work Q is set as 256, which increases number of small regions. Gaussian filters are used to smooth the image to remove noise. Sobel filter mask [1 2 1] is used to find image gradients between neighbour pixels .To generate pair pixel intensity difference can also be calculated as given in (4).

$$f(p,p')=|p-p'| \qquad \text{---(4)}$$

where p and p′ are pixels of region R and R′ respectively. Here pixels are sorted in ascending order, this motivates to generate pairs(p,p′). Images are segmented using SRM algorithm without any pre-processing. This feature is the main advantage of this algorithm. In four connectivity graph, the neighbourhood pixels are considered in horizontal vertical directions. Therefore image gradients for both directions to find edge pixel (∂x, ∂y) are needed. The pixels which are having high image gradient value are identified as edge pixels.

4. CONCLUSION & FUTUREWORK

In this paper as a part of the frame work SRM algorithm is implemented to classify the pixels as normal or lesion to get segmentation map. Q parameter controls the regions to be segmented. To correct illumination variation MSIM algorithm is used. V channel in the HSV color space is downscaled to get illumination map. In future illumination variation would be corrected and using Modified TDLS algorithm the skin lesion would be segmented, unique features of skin lesion will be extracted and will be classified as melanoma or non-melanoma using SVM classifier.

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