A Noble Imaging Technique To Detect Human Skin Scar

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Abstract— Variation of human skin tone is a big challenge for analyzing human skin scar because of insufficient detecting criteria and technique in automated analyzing system. Detecting skin scar on the basis of skin tone by image processing can help to make decision for minimizing time delay and cost of different medical tests. Different types of image processing methods, functions, and techniques are used for analyzing skin scar to make an automated skin scar recognition system which will help to get idea about skin tone, skin scar, lesion and the position of scar and lesion in human body. Image acquisition for analyzing and extracting information from skin scar's sample, and overall process have done by digital image processing on the basis of input image's pixel variation.

Index Terms— Image acquisition, Gray-scale, Threshold, Histogram, morphological processing, Edge detection, and Object Recognition.

1 Introduction

Detecting human skin scar is a difficult task because of different type of birthmark, tattoo, and complexity of human skin which are main obstacle to isolate scar from different human organ. Different type of human skin color [1] which are different from person to person also interrupt to understand skin scar by imaging technique. 3D optical coherent [2] method is successfully used in medical image processing to analyze and extract desire medical object so the noble imaging technique to detect human skin scar are very basic method for tracking scar in human skin like histogram analysis, threshold, color matching, number of pixel analysis and object tracking.

2 Background

The Fibrous tissue creates scars which are appeared in regular skin after injury and it results from the biological process of wound repair in the skin and other tissues of the skin [3]. So, scar is considered as a natural part of the healing process. Usually with the exception of very minor lesions for human, every wound results such as after surgical operations, accidents and diseases in some degree of scarring [4]. Animals are free from scars, their tissue can regenerate without having scar formation [3], [4].

In this research we are working with any type of human scar which are comparatively small size like scratches, birthmark, and lesions so that it is easy to analyze and extract information. In this case all raw image which are input image should be same and fixed pixel ratio.

Many researches have already done to analyze human skin such as: skin cancer [5], skin disease [6], and skin allergy [7]; but most of them are complicated and take long time to process. Skin scar is one of the important fact to extract information. For this reason, our methods and techniques should be simple and able to produce faster result.

To achieve the aim of this research we should make this process as much as simple and effective, thus the basic different types of image processing techniques will be the main equipment and method of this research. The details about the imaging methodology are discussed in the description part. This noble imaging technique can be used largely in the field of medical science, specially for analyzing patient's skin, for checking the fitness, and also for ensuring better treatment. It can be helpful for catching criminals because sometimes smugglers hide illegal things inside their body skin for smuggling purpose.

3 Description

Several imaging techniques should be followed to get the clear view of skin scar so it is effective way to achieve objective of this research. An algorithm is presented to detect skin scar in different steps where each step contains different image processing method to establish our research aim.

3.1 Analyzing Scar By Histogram

In the image processing field, the histogram normally indicates to a histogram of the values of pixel intensity of an input image. This histogram is a graph, who shows the pixel number in an image with each various intensity value found in the input image[8]. There are 256 different possible intensities in an 8-bit gray-scale image, and so by graphically display, the histogram represents 256 numbers with showing the combination of pixels into those values of gray-scale[9]. It can also be taken from color images, most of the time separate histograms of red, green and blue channels can be taken and rest of the time a 3D histogram can be generated, with the three axis containing the red, blue and green channels, and the brightness at each point indicating the pixel count [8, 9]. The operation's output depends on the implementation, whether simply it can be a picture of the desired histogram with an appropriate image ordination, or can be a data file by illustrating the histogram statistics. Fig. 1 shows the processing of histogram image.

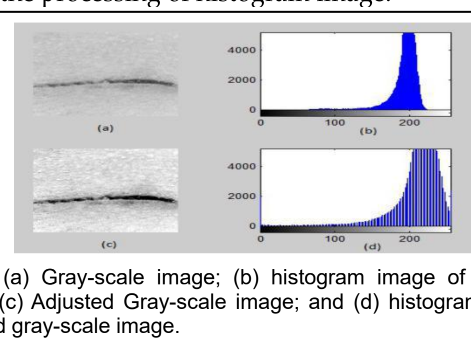

Fig. 1: (a) Gray-scale image; (b) histogram image of gray-scale image; (c) Adjusted Gray-scale image; and (d) histogram image of adjusted gray-scale image.

3.2 Comparing scar with threshold

The simplest and easy method of image segmentation is thresholding which is used to create binary image from a gray-scale image [10]. The easiest thresholding techniques replace each pixel in an image with a white pixel if the image intensity is greater than some fixed constant T, or a black pixel if the image intensity is less than that constant. To run automated threshold, it is mandatory to select automatically threshold T for the computer. Sezgin and Sankur (2004) categorize threshold techniques into the six groups based on the information of the manipulates algorithm [11]. Here, input image is operated by threshold methods to segment the scar area. Fig. 2 shows threshold process of input image.

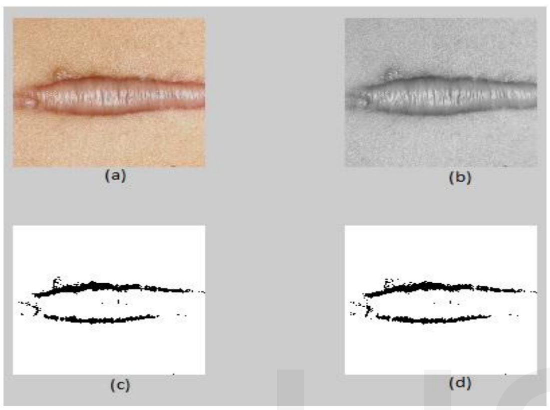

Fig. 2: (a) Input image; (b) Gray-scale image; (c) Binary image; and (d) Binary image where T=200.

3.3 Morphological Dilation and Erosion

In the field of mathematical morphology, dilation and erosion are two basic operators [12]. Both of them are usually applied to binary images, but there are different versions that use on gray-scale image processing [12, 13]. The basic impact of the dilation operator on a binary image is to stepwise expand the boundaries of areas of foreground pixels which is white pixels usually. In this manner, the regions of foreground pixels generate in size while holes within these regions become miniature [15]. The dilation operator requires two types of data as inputs. One is an input image which is to be dilated. The other one is a set of coordinate points which is called as a kernel or structuring element [16]. The kernel determines the accurate effect of the dilation on an image [15, 16]. For binary image to express the mathematical definition of dilation:

Consider that X is the set of Euclidean coordinates corresponding to input image, and that K is the set of coordinates for the kernel [13]. Now, Kx denote the translation of K, so its origin is at x. The dilation of X by K is only the set of all points x that the intersection of Kx with X is non-empty. In mathematical definition, the gray-scale dilation is uniform, but it is different for the way in which the set of coordinates linked with the binary image is executed [14]. Moreover, these coordinates are 3D rather than 2D for dilation and erosion both. Fig. 3.1 shows binary to dilation process.

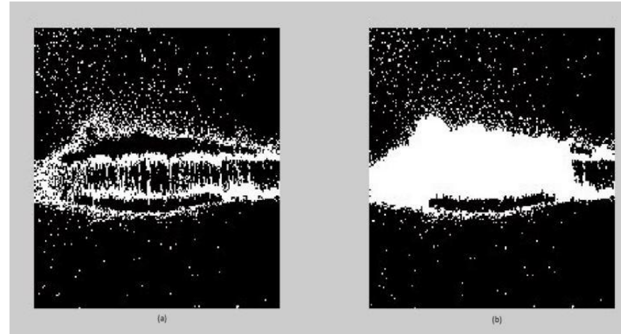

Fig. 3.1: (a) Binary image; and (b) Dilation image.

On the other hand, the basic effect of the operator on a binary image is to erode away the boundaries of regions of foreground pixels which is white pixels usually [14]. In this way, the regions of foreground pixels shrink in size, and holes within those regions become larger [15]. The erosion operator takes two types of data as inputs. One is an image which is to be eroded. The other one is a set of coordinate points called as a kernel or structuring element [16]. The kernel determines the exact effect of the erosion on an input image [15, 16]. For binary image to express the mathematical definition of erosion:

Consider that X is the set of Euclidean coordinates corresponding to input image, and that K is the set of coordinates for the kernel [13]. Now, Kx denote the translation of K, so its origin is at x. The erosion of X by K is only the set of all points x that Kx is a subset of X. In mathematical definition, the gray-scale erosion is uniform, but it is different for the way in which the set of coordinates connected with the input binary image is executed [14]. Fig. 3.2 shows dilation to erosion process.

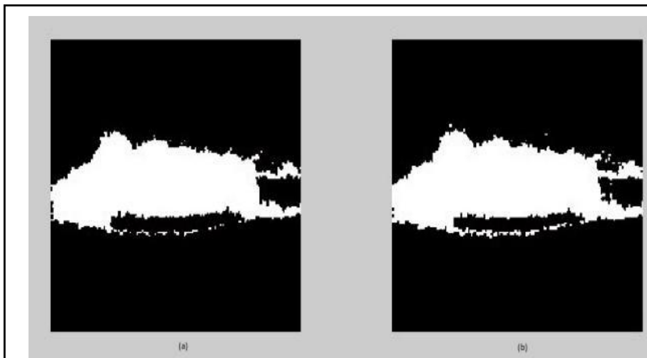

Fig. 3.2: (a) Dilation image; and (b) Erosion image.

3.4 Segmentation by Otsu's Method

Otsu's method is used to automatically perform clustering-based image thresholding [17], and sometimes the reduction of a graylevel image to a binary image in image processing. The method assumes that the image comprises two pixel-classes by following bi-modal histogram such as: background and foreground pixels, then it enumerates the optimum threshold isolating the two pixel classes, as a result their combined spread means intra-class variance is minimal, or equivalently where the sum of pairwise squared distances is constant, and that's why their inter-class variance is maximal [18]. In this way, Otsu's method can be used to isolate skin scar from skin to to show the scar in better way.

Basically, in Otsu's method we broadly looking for the threshold value that minimizes the intra-class variance, ascertained as a weighted sum of the two class-variances:

$$\sigma_w^2(t) = w_0(t)\sigma_0^2(t) + w_1(t)\sigma_1^2(t)$$

Here, weights w_0 and w_1 are the probabilities of the two classes, who are separated by a threshold t and variances σ_0^2 and σ_1^2 . From the L histograms, the probability of class $w_{0,1}(t)$ is calculated:

$$w_0(t) = \sum_{i=0}^{t-1} p(i)$$

$$w_1(t) = \sum_{i=t}^{L-1} p(i)$$

This method proves that minimizing the intra class variance and maximizing the inter-class variance both are same.[18]

$$\sigma_b^2(t) = \sigma^2 - \sigma_w^2(t) = w_0(\mu_0 - \mu_T)^2 + w_1(\mu_1 - \mu_T)^2$$
$$= w_0(t)w_1(t)[\mu_0(t) - \mu_1(t)]^2$$

It is elicited in terms of class probabilities w and class-means μ .

Where the class-mean $\mu_{0,1,T}(t)$ is:

$$\mu_0(t) = \sum_{i=0}^{t-1} i\frac{p(i)}{w_0}$$

$$\mu_1(t) = \sum_{i=t}^{L-1} i\frac{p(i)}{w_1}$$

$$\mu_T = \sum_{i=0}^{L-1} ip(i)$$

For easily verifying, we can write:

$$w_0\mu_0 + w_1\mu_1 = \mu T$$

$$w_0 + w_1 = 1$$

Now we can compute interatively the class probabilities and class means, so this method yields an efficient algorithm. Fig. 4 shows image segmentation by Otsu's method.

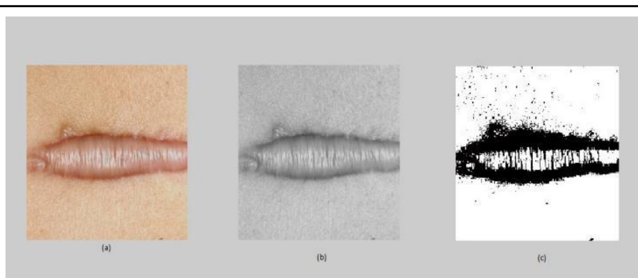

Fig. 4. (a) RGB image; (b) Grayscale image; and (c) After applying Otsu's Method.

3.5 Adaptive Threshold

Adaptive threshold are used for image segmentation where it uses a color or gray-scale image as input and produces a binary image [19]. The threshold has to be considered for each pixel of the image. It is set to the background value If the pixel value is below the threshold, else it takes the foreground value. Two main approaches are used for finding the threshold [20], one is the Chow and Kaneko approach and second one is local threshold [21]. The presumption of both techniques is that smaller size image ares are more likely to have roughly uniform clarification, so being more appropriate for threshold. The Chow and Kaneko approach divides the input image into an array of overlapping sub-images, after that by investigating its histogram, finds the optimum threshold of every sub-image. The interpolating results of the sub-images find the threshold for each single pixel. Another way to find the local threshold is examine the intensity value of the each pixel's local neighborhood by statistically. The statistic is most appropriate depends widely on the input image. The mean of the local intensity distribution is included by fast and simple functions [20],

$$T = mean$$

The median value,

$$T = median$$

and the mean of the maximum values and minimum values,

$$T = \frac{\max + \min}{2}$$

To cover adequate background and foreground pixels, the neighborhood size has to be great enough else a low threshold is approved. In the other side, approving ares which are too big in size can transgress the supposition of roughly uniform clarification [21]. This technique is less computationally sharp than the Chow and Kaneko method and provides a better output for analyzing scar. Fig. 5 shows adaptive process from Otsu's method applied image.

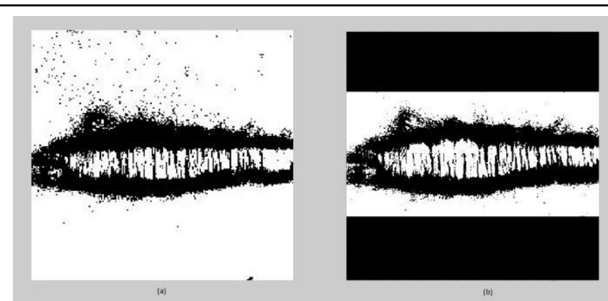

Fig. 5. (a) After applying Otsu's method; (b) Adaptive image.

3.6 Analyzing Property of scar

For detecting skin scar we should analyze two major properties of scar such as color of scar and measure the scar by pixel number so that our next imaging technique approaches to determine these properties.

i. Color analyzing

Color analyzing of scar is most important for understanding pattern of skin scar. For color segmentation, isolating different color of scar is mandatory; so that for specific input image, should find out some points pixel value. Then we get specific highest and lower RGB value for those points. In our algorithm, we use this highest and lower value (0-255) to get the specific color of skin scar from input image [22]. For example, we use the below command to get white color in input image.

red=handles.aa(:,:,1);
green=handles.aa(:,:,2);
blue=handles.aa(:,:,3);
out= red>200 & red<225 & green>200 & green<225 & blue>190 & blue<225;

So, according to input image of skin scar, need to change the range for different colors. Fig. 6 shows color analyzing of input image in red, black and white.

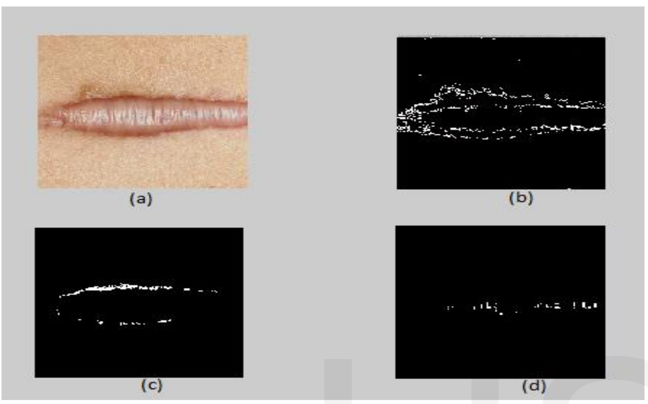

Fig. 6. (a) input image; (b) red pixel in scar; (c) black pixel in scar; and (d) white pixel in scar.

ii. Measuring Skin Scar

Binary image contains with black and white pixel which are known as 0 and 1 [23]. So our image processing technique can show different properties of skin scar from binary image such as scar length, width, total pixel number of skin scar and percentage of scar in binary image for a certain image ratio. Here is Matlab Command:

bw=edge(binary_image);
[row,column]=find(bw);
W=sum(bw(:)) [total pixel number]

After getting total pixel number of scar in binary image, should find out the length and width of scar. So-

x2=max(row); x1=min(row);
X=x2-x1 [Length of X axis, scar length]
y2=max(column); y1=min(column);
Y=y2-y1[Length of Y axis, scar width]

To get the percentage of skin scar in binary image- TS will be divided by T and then result will be multiplied by 100.

TS = Total number of scar pixel in binary image
T = Total number of pixel in binary image

$$Scar\ \% = \frac{TS}{T} * 100\ \%$$

4 Experimental Result and Analysis

After completing all imaging techniques, some specific analyzing outputs are found which are related with pixel number. They are listed in the Table 1.

Table 1: List of total pixel of scar and percentage of scar in skin for different samples.

Sample no.	Total pixel of scar	Percentage of scar in skin
1	1263	6.9
2	2140	12.5
3	1350	7.0
4	1100	6.0
5	2000	11.5
6	1805	10.9
7	1519	8.5
8	2347	15.0
9	2569	16.9
10	1763	11.7
11	2210	14.0
12	1750	11.5
13	1955	11.3
14	1670	10.0
15	1150	6.5

Initially 1000 samples are taken to experiment our noble imaging technique. Here some sample data are shown to represent the result of analyzing skin scar according to the total pixel number of scar and the percentage of scar in skin for a certain sized image ratio. Fig. 7.1 shows total pixel of scar in different samples and Fig. 7.2 shows percentage of scar in skin in different samples.

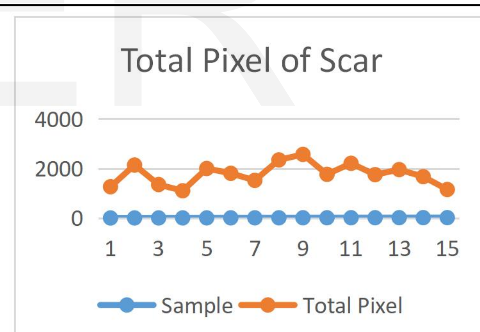

Fig. 7.1. Total pixel of scar in different samples.

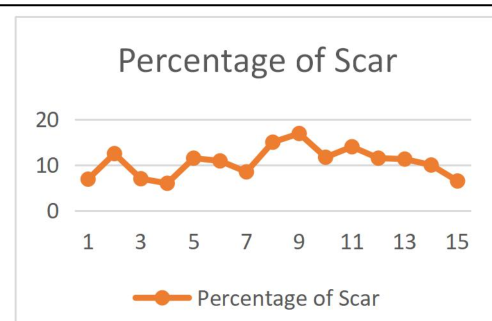

Fig. 7.2. Percentage of skin scar in different samples.

5 Conclusion

In this research, we have tried to established some methods to solve detecting problem of skin scar according to skin tone analyzing algorithm. Sample images of patient's good skin of nearest scar area and lesions are the inputs for this system. Image acquisition process is the most important part of it, because focus distance and pixel ratio can change the whole output and result. It is also important to understand the position of lesion on human body; the reason is the treatment and classification criteria have depended on according to the position of scar and lesion. Different algorithms of image processing help to get idea about the criteria of skin scar analysis which can help to make a decision for medical treatment.

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