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Novel Reliability Analysis of Skin Burn Images Obtained Using Image Processing

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***Abstract*—** Treatment for burn injuries depends highly on the type of severity of the burn. Thus, identification of the severity of burns plays a very important role in providing proper treatment to patients suffering from skin burns. With digitization of images using image processing, the treatment becomes easier by properly classifying these skin burn images and identifying the severity of these burns using the some scientific techniques. The color of the skin burn images are represented by Red Green Blue (RGB) histogram. Lot of research has been done in using the RGB histogram to develop different algorithms and methods of classification and also to assess the severity. However, because of the drawbacks in each of the algorithms in one or the other way, there is no single method or algorithm that fits in all the situations. As an alternative, the statistical properties of histograms can be used to assess the severity of burn images by assessing the reliability of burn images, which in turn, helps in providing proper treatment to the patients suffering from burns. The RGB histogram of burn images can be used as a basis for this. The RGB band of burn images have Gaussian distribution and this information can be used in determining the reliability and hence the severity of the burn wounds. Herein, it is intended to assess and analyze the reliability of skin burn images through this Gaussian distribution, using statistical procedure. Some past data obtained through clinical observations have been used for obtaining the same.

***Keywords*—**Gaussian distribution, Intensity histogram, Reliability analysis, RGB classification, Skin burn.

I. INTRODUCTION

A burn is an injury to the skin, which is caused by heat, radiation, electricity, friction or contact with chemicals. Burns on skin occur when skin cells are destroyed by hot solids, liquids or even flames.

Classification of burns [1]: Burns are classified depending on the depth of the injury. Such classification helps in determining and providing proper treatment to the patients suffering from such skin burns. The four types of skin burn are:

1st Degree - redness of skin without blisters.
2nd Degree - redness with blisters.
3rd Degree - skin is white and leathery, which indicates complete damage to skin.
4th Degree - Same as third degree but with damage is caused to innermost structures such as tendons, joints and bone.
Sample images of these classifications are shown in Figure 1. Figure 2 shows the depth classification of burn inside the skin.

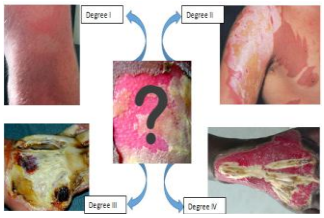

Figure 1 Skin burn images

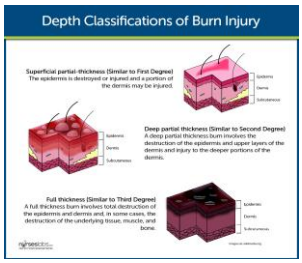

Figure 2 Depth classification

First and second degree burns have less impact on the lives and can be cured easily. However, long time treatments are needed for patients suffering from 3rd and 4th degree burns. These burns may also lead to loss of life. Few sample images

of third and fourth degree burns, taken from patients admitted to a hospital are shown in Figure 3 and Figure 4 respectively. Without the correct assessment of the degree of the burns, proper treatment will suffer.

Figure 3 Third degree burns

Figure 4 Fourth degree burns

Digital images of the burns help in identifying the degree of these burns. The most commonly used colour scheme of burn images is RGB (Red, Green, Blue) [2]. The block diagram of the process involved in processing of digital images is shown in Figure 5.

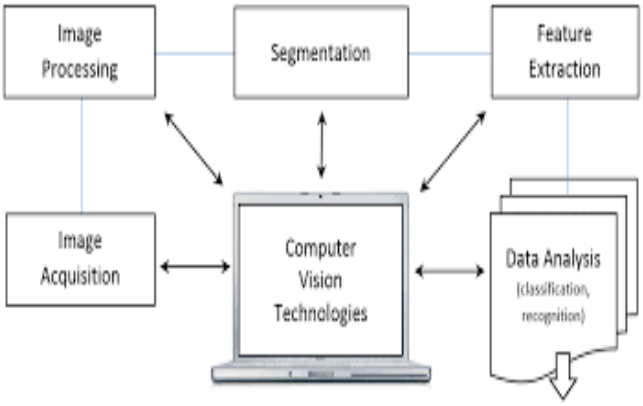

Figure 5 Processing of digital images

RGB Intensity Histogram:

Histogram is a graphical representation of the data. In image processing, the histogram of an image refers to a histogram showing the number of pixels in an image at each different intensity value of that image. The color of the skin burn images are represented by Red Green Blue (RGB). Thus, a colour histogram of red, green and blue channels are considered for image processing. A sample RGB histogram is shown in Figure 6. Figure 7 shows the separate histograms of the distribution of red, green and blue colours.

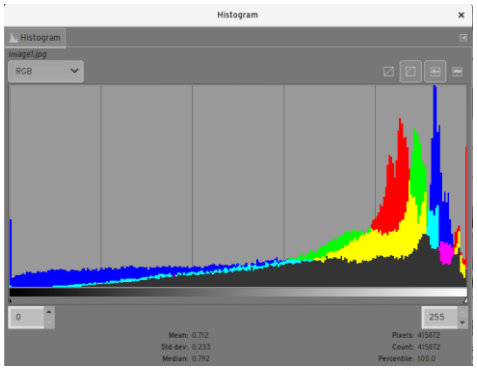

Figure 6 Intensity histogram of burn

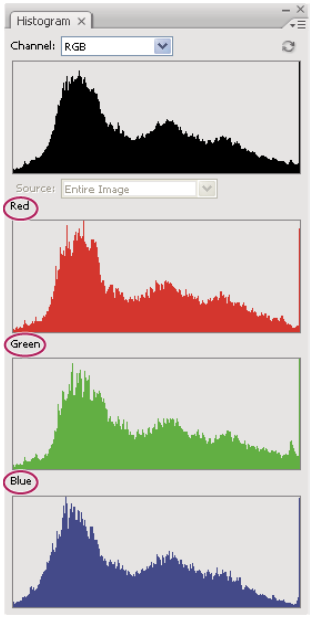

Figure 7 RGB Histogram

Using the histogram, the probability distribution of the burn wounds can be obtained. Through probability distribution, the reliability analysis of these burn images can be made. The reliability analysis helps to determine the severity of burns and hence the time taken to cure the burn wounds with proper treatment. Frequency distribution of sample pixel values of a burn injury is shown in Figure 8.

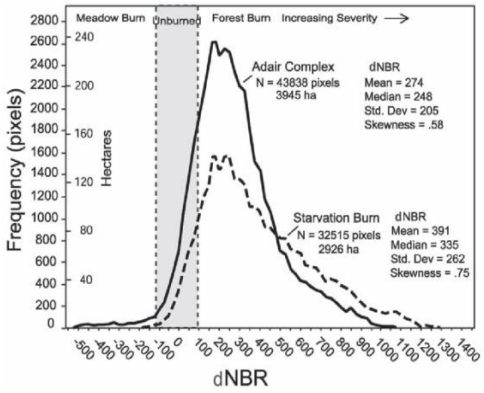

Figure 8 Frequency distribution of pixel values

The complete organization of the article is as follows: Section I contains introduction of burn injuries, classification of burn injuries and RGB intensity histogram of burn images. Section II contains the literature review pertaining to the research work, along with objectives and motivation of the work. Section III deals with analyzing the reliability of burn images using the probability distribution of intensity histograms. Section IV concludes the research work with future directions.

II. LITERATURE REVIEW AND OBJECTIVES

Some of the research works pertaining to analysis of skin burn images are:

Hong-yan Li [3] determined the degree of skin burns by computer image processing method. Photoshop9.0 software, was used to analyze the statistical property of histogram of skin burns images. These images were then transformed from RGB color space to HSV color space, in order to analyze the transformed color histogram. the percentage of the skin burns area was obtained through Photoshop9.0 software. The burns were evaluated to find burn score, using the mean and the standard deviation of color maps. Malini Suvarna et al [4] diagnosed burn images using template matching, k-nearest neighbor and artificial neural networks. The automated method involved creation of database of skin burn images obtained from hospitals. The burn images were then classified using different methods. It was then deduced that ANN technique could be applied to analyze and classify the severity of burns. Malini Suvarna et al [5] also proposed classification methods of skin burn images, wherein, the severity of skin burn were automatically detected and categorized. Some pattern recognition techniques, viz, Template Matching (TM), Knearest neighbor classifier (kNN) and Support Vector Machine (SVM) were used for the same. Begon˜a Acha et al [6] segmented and classified the burn images by color and texture information. The aim was to separate healthy skin and burnt skin and to distinguish the different types of burns (burn depths). After segmentation of burns, set of color and texture features were calculated, using neural network techniques. The average classification success rate was established to be 82%. Hai Son Tran et al [7] recognized the degree of skin burns images using convolutional neural network. The aim was to build automated computer aided to identify the degrees of burn images. The model proposed was called B-CNN (Burn Convolutional Neural Network). The feasibility of the model was established using some experimental results. T. S. Hai et al [8] proposed a real time image classification for burn image to identify II, III, and IV degrees burns. The model used One-class Support Vector Machine instead of traditional Support Vector Machine (SVM).

Motivation and Objectives: The burn images were analyzed in different ways by different researchers. Most of them concentrated on analyzing the severity of the burn and their classification. Herein, it is intended to adopt a different method of analyzing the skin burn by obtaining the reliability function and analyzing it by making use of the intensity histogram of burn images. The aim is to obtain the reliability function and hence identify the severity of the burn. Through proper analysis of this reliability function, it is possible to provide some benchmark suggestions in providing proper treatment to the patients suffering from such skin burns.

III. RELIABILITY ANALYSIS

It has been observed that the probability distribution of the red, green and blue bands follow Gaussian distribution with probability density function

$$f(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(x-\mu)^2}{2\sigma^2}} \qquad x>0,\ \mu, \sigma>0. \tag{1}$$

where the random variable X denotes the burn time. The parameters μ and σ denote the mean and the standard deviation of X respectively.

The reliability function of this Gaussian random variable, denoted by $R(t)$ is obtained as

$$R(t) = P(X > t) = \int_t^{\infty} \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{(x-\mu)^2}{2\sigma^2}} dx . \tag{2}$$

Standardizing the variable X through the transformation $Z = \frac{X-\mu}{\sigma}$, the reliability function is obtained as

$$R(t) = 1 - F(t) = 1 - \Phi(t) \tag{3}$$

where $\Phi(t)$ is obtained from standard normal table, for a given value of t.

The behaviour of this reliability function for various values of t can be observed with the help of a sample burn time data [3].

Table 1 denotes the burning time of a 3rd degree burn and the values of reliability function, obtained using standard normal table. Figure 9 denotes the behavior of this reliability curve.

Table 1 Sample burn time data and reliability of 3rd degree burn

Burn Time (minutes)	*F(t)*	*R(t)*
0.0833	0.5319	0.4861
0.1666	0.5636	0.4364
0.25	0.5987	0.4013
0.3333	0.6393	0.3607
0.4166	0.6591	0.3409
0.5	0.6915	0.3085
0.5833	0.7190	0.281
0.6666	0.7454	0.2546
0.75	0.7734	0.2266
0.8333	0.7967	0.2033
0.9166	0.8186	0.1814
1.0	0.8413	0.1587

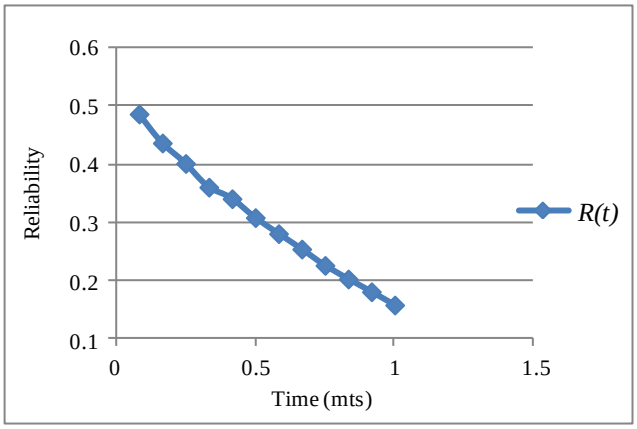

Figure 9 Reliability curve of a sample 3rd degree burn

IV. CONCLUSION AND FUTURE SCOPE

The processing of burn images proves to be a major milestone in the field of image processing. These processed images play major role in identifying the severity of the burn injuries, thereby assisting the doctors in providing proper treatment. The processed burn injuries exhibit three kinds of colour combinations, viz, Red, Green and Blue. Each of these colours indicate the intensity with which, the burn occupies the inner layers of the skin. Since the rate at which the burn injury spreads to the inner layers is random in nature, the RGB colour bands are seen to have certain patterns, which can be thought of as following certain probability distributions. It can be seen that the RGB patterns follow Gaussian distribution. The reliability function of this Gaussian distribution is used in assessing the reliability and hence the severity of the burn. Herein, the burn time data of a sample burn injury of a third degree burn is considered and the reliability function of this Gaussian distribution has been obtained using standard normal distribution table. The pictorial representation of this reliability function, as obtained in Figure 9, indicates that the reliability drops off rapidly with time. As seen from the curve, within a minute, 90% of the area is occupied by the burn. This analysis obtained from the past data, helps the doctors in assessing the severity and spreading of the burn into the inner layers of the skin and hence helps them in assessing the severity of the burn, thereby in providing proper treatment.

The work can be further enhanced to test the efficiency and effectiveness of this reliability, by using certain statistical tests.

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Authors Profile

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