

Epidermal Wound Assessment by Fuzzy Morphology & Imaging

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Abstract: Healing of wound is very critical and complicated process. The computational approach to monitor and assess a wound gives a pronounced way to have a conclusion about the condition of wound. This is a new approach to assess wound healing process. This proposed work would give epidermal wound assessment by monitoring a single digital image. Classification of image computationally is not possible for human eyes. This work can generate a clear image analysis by imaging the wound along with the reduced noise and image clarity.

Keywords: Wound assessment, Digital image processing, Fuzzification, Morphological image analysis.

1. Introduction

Epidermal layer is composed with tightly packed cells. These cells are arranged in layers. Our approach is to observe the wound surface at the upper layer of skin. In case of deep dermal wound image is not a solution to find the clarity and depth of the wound. Wound can be proliferated by cell divisions and migratory movement of the motile component of skin. An image of a wound cannot provide a computational clarity. Day by day improvement needs close computational monitoring of the wound. Image clarification comes from proper classification and grouping of discrete value at pixel level. By means of image processing classification refers that to place a particular image along with the pixel monitoring into a predefined category. This approach can reduce the noise level and ill positioned problem of pixels.

2. Method & Morphology of wound Image

Digital image of burn wound is taken as input image from several burn patients. This performance is done at S.S.K.M hospital, Kolkata India. It has been approved by institutional ethics committee. Fuzzy technique can manage the vagueness and ambiguity. The efficiency can be higher by generating the fuzzy sets [7, 8]. The fuzzification is done by creating proper fuzzy membership functions. [1] Membership functions can be chosen by piecewise linear function, Gaussian distribution function, Sigmoid distribution, Quadratic and polynomial distributions. Image fuzzification followed by modification of fuzzified value. In fuzzification technique the set of membership function matters according to the degree of choice of an object set, Degree in terms of membership function compatibility represents the fuzzy set. An image is considered as fuzzy sets. Considering an image with size $M \times N$ sets can be considered as

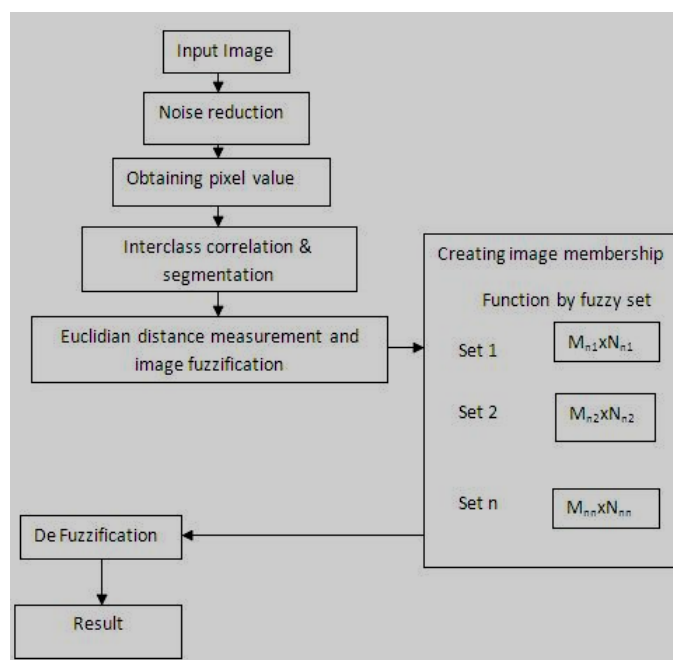


Figure 1: Proposed model of wound image morphology for clinical assessment

3. Mathematical model implementation of wound image morphology

A source Image is taken from a digital camera. The picture of a wound considered as an $M \times N$ dimensions. It's an array of fuzzy segmentation. The segmentation is done over the intensity value of the spatial matrix of a pixel. This is done over MATLAB 7 platform. Membership function is created which work over discrete pixel. Indexed and Gaussian membership function is merged together to have a smooth value and adjacent pixel edges value. The nearest distance in between the two pixels is considered as x . Where x is in $[M, N]$ dimension [3,5]. To have a proper classification K nearest

neighbor algorithm is used to find out the nearest distance of a same class. Class is denoted as a function of colour (R G B) subsets.

$$x = \sum_{i=1}^n 1 - \{(Mi - Ni)\}^{1/2} \quad (1)$$

M and N the dimensions considered for the spatial matrix.

$$\mu_{mn}(x) = \exp \frac{-(A - x)^2}{2\sigma^2} \quad (2)$$

$\mu_{mn}(x)$ is Gaussian membership function. A is the centre and σ is the width of a pixel these are considered as a fuzzy set. Similar interclass correlation and intensity [indexed] matrix value will produce similar sets [7]. This function is modified with the linear indexing with respect to sets. The different RGB values produces different schematic to identify the wound. The value comes from this analogy can be used to identify the Euclidian distances. This step will help to define edge satisfying uniformity. The M and N can produce a histogram to read the pixel information.

$$S = 1/MN \sum [\mu_{mn}(x), 1 - \mu_{mn}(x)] \quad (3)$$

S stands for a set. Morphological operation works over the domain of erosion and dilation technique. They are being generated by the spatial value of intensity matrix of a pixel. Those sets are producing structuring element of pixel for an image. This equation can be applied over set 1, set 2, set n. Where modification function works over x, which is interclass correlation value of each pixel. Equation (2) gives a linear indexing of each set consisting pixel matrix segmented with indexing. The distance between two pixels is found along with the value. If the value of two neighboring pixel gives the same value it would generate a same class and a same set. Dilation gives the diverging transformation of a wound surface and erosion gives the converging transformation of a wound surface.[2,3,4]

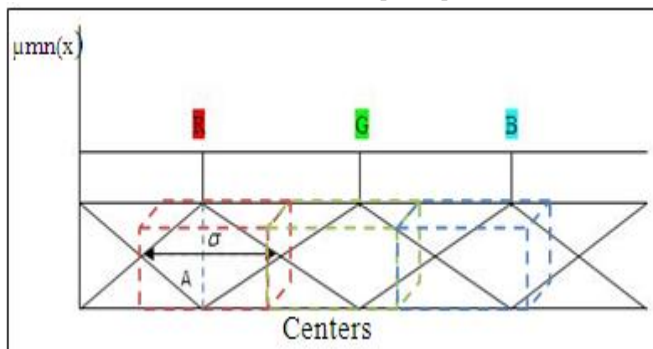


Figure 2: Fuzzy sets along with function modifiers

4. Algorithm for morphological wound image Analysis

The Image which is fuzzified operated followed by morphological operator like open with closing along with the masking element mask filter. The algorithm for the proposed work is

- Step1: Read the wound image.
- Step2: Consider the result of proposed model at Figure 1.
- Step3: Masking

Step4: Morphological “Erosion, Dilation, Open with Closing” operation.

The proposed approach is simulated in MATLAB 7 environment and applied on several burn wound images. The results after approaching this model are compared with non fuzzy wound images. The noise has been deducted through the proposed model so the clarity and accuracy rate can be determined.

5. Experimental Result

Several burn wounds are investigated o establish this approach. The chronic burn wound image is taken by a simple digital camera. The RGB image is converted to the indexed image. The class assignment is followed by the pixel value [11,13].The source image is fuzzified according to the proposed model and pixel value is considered through MATLAB 7 platform. Non fuzzy image was containing noise. The implementation of fuzzy morphological function over discrete pixel over a limited domain the picture clarity can be compared.

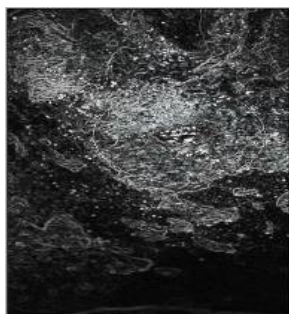
Table 1: Wound assessment over proposed model

Wound Image	Pixel difference wise membership function Value Considering (total wound area-open wound area) before and after treatment over same [MixNi,i ≤ n] matrix domain	Remark % of Epithelization
Image a	Fuzzified over (3208700-324567)	89.8%
Image c	Fuzzified over(4235610-234549)	94.4%
Image e	Fuzzified over(2341235-209874)	91.03%

Table 1 shows the pixel wise difference for total affected wound area indexed matrix pixel value and open wound area [12,10,13] indexed matrix pixel value. The remark gives the epithelization level for understanding a burn wound. The epithelization of epidermal burn wound can be much more prominent from pixel value wise depth map plotting from figure 6.



(a)



(b)

Figure 3: (a) Wound Image (b) Image segmentation By image class correlation



(c)



(d)

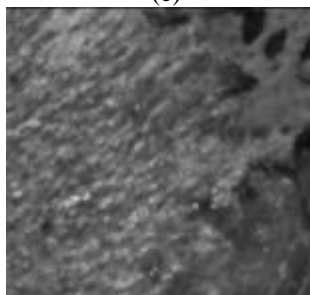
Figure 4: (c) Wound Image (d) Image segmentation By image class correlation



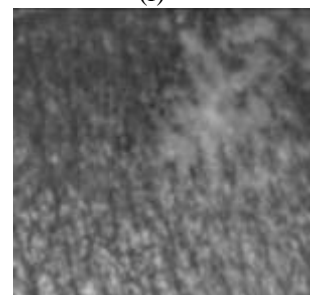
(e)



(f)



(g)

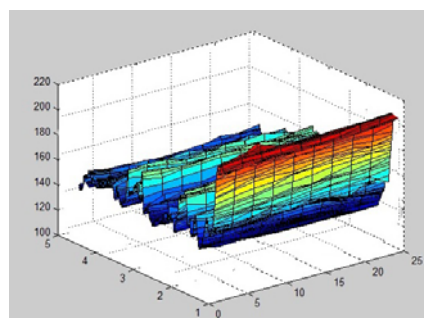


(h)

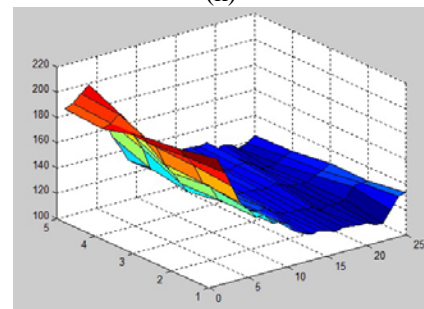


(i) (j)

Figure 5: (e) Wound surface before treatment (f) Same surface after treatment 3 weeks later (g) Fuzzified image of wound image before treatment (h) Fuzzified image of wound after treatment. (i) Contour wise segmentation of indexed image of (e) & (f)



(k)



(L)

Figure 6: (k) Surface Graph of before treatment wound image and (L) after treatment wound on same pixel domain

Table 2: Wound image assessment on pixel wise distance measurement for five adjacent pixels

Image Name	[Mi x Ni] Pixel wise mean difference for adjacent pixels, n=5	x Mean value
a	2524133	1262067
c	3601461	1800731
e	2131361	1065681

6. Discussion

This proposed work is based on a new technique which reduces the noise. It gives a technique which smoothen the epidermal layer wound picture. This fuzzy logic is a new area of research which gives clarity of an image. Morphological analysis is based on set theory. This analysis produces a spatial matrix of selected pixel value. From that matrix the fuzzy modifier function is generated which produces an image clarity to study and assess the wound condition.

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