Images of Cutaneous Ulcers Classified by Artificial Neural Network

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Abstract

Treatments of leg ulcers are generally made by direct manipulation for analysis of its evolution. The treatment efficiency is observed through the reduction of the size of ulcers in relation to the amount of tissues found in their beds, which are classified as granulated/slough. These results usually are obtained through analyses performed after consultation due to the time these analyses take. This work proposes a new non-invasive technique for the follow-up of treatments aimed at cutaneous ulcers. In this technique, it was proposed that digital photos of cutaneous ulcers would be submitted to an artificial neural network, so that all surrounding the wound except for the wound itself could be extracted (skin/background), thus obtaining the ulcerated area. Computer vision techniques have been applied in order to classify the different types of tissues in the ulcer bed. The results obtained have been compared with the results obtained by Image J software.

Keywords: Leg Ulcer, Computer Vision, Artificial Neural Network.

1. Introduction

The treatment of leg ulcers presents some complications due to its long-term characteristic, discomfort of curatives and uncertainness in relation to its success, once its cure depends on several factors that act as intervenient variables in the process, causing significant social and economic impact [1-2-7]. The treatment is painful, expensive and slow due to a number of associated etiopathogenic factors, and the disease represents one of the main causes for work absenteeism.

The use of computer tools involving image processing and artificial neural network (ANN) consists of an alternative analysis method for the follow-up of leg ulcer treatments. This method does not allow the direct contact with the wound, once ulcers are analyzed through digitized images [3]. Therefore, the health professional disposes of tool designed to support the treatment of ulcers.

This work also proposes the development of technique to classify leg ulcer tissues in order to support specialists along the treatment evolution. The employment of computer software with the proposed technique may lead the patient to feel safer, since there is no direct contact with the wound to obtain samples for analyses [3].

2. Material and Methods

The images randomly selected from the image bank were standardized and non-standardized in relation to zoom, illumination, distance between the camera and the patient's leg and the focus in the patient's leg. Fifty images were selected to test the validity of the proposed application. That images were obtained from the ADUN image bank (Neurovascular Ulcer Dermatology Ambulatory) and from the CSE (School-Health Center) – FMRP/USP (Ribeirão Preto Medical School, University of São Paulo) provided by Prof. Dr. Marco Andrey C. Frade – Dermatology Division of the Department of Medical Clinics - FMRP/USP.

The MLP Feedforward neural network architecture was used with the Backpropagation training algorithm, which was the architecture most used for classification in several areas.

The application proposed is divided into two phases: in the first phase, the extraction of the color characteristic and the ANN training occur (Training Phase) [6]. The second phase consists of segmenting images (ANN Test), application of digital image

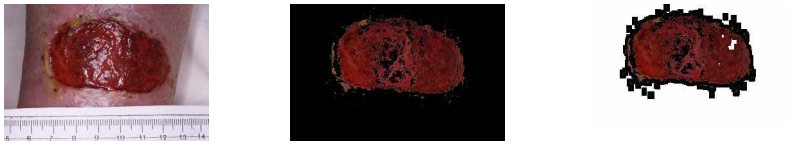
processing techniques for the elimination of noises, improvement of the image quality and later tissue classification in the wound bed and subsequent calculation of the leg ulcer wounded area in cm^2 – Test Phase [6].

Initially two algorithms were applied to images in order to obtain, skin, ulcer (bed) and background (all except skin and ulcerated area) color, which will serve as inputs for the ANN training to distinguish the color characteristics of the wound edge from the other colors not involved in the wound thus, forming training standards. Each color characteristic of the selected region is stored in a text-type file to form the feature vector.

These two matrixes will form the "training patterns", which will be used for the training. The parameters used in the neural network of this methodology may be observed in Table 1.

Table 1. Values of the neural network parameters.

Parameter	Value
Neurons in the 1st hidden layer	4
Neurons in the 2nd hidden layer	4
Neurons in the 3rd hidden layer	1
Moment Term	0.5
Maximum Number of Iterations	1000
Training Error Rate	$1x10^{-3}$



(a) (b) (c)

Figure 1. Figure Example. (a) Original Image – (b) Pre-Processed Image – (c) Post-Processed Image.

3. Results and Analyses

The 50 test images were applied to the proposed technique and to the freeware software Image J [4] for comparison because this software is used in the Dermatology Division of the Department of Medical Clinics - FMRP-USP - for the analysis of the leg ulcer images.

The results obtained through the Image J freeware software and with our technique seemed to be equilibrated and close to each other to total area and each type of tissue, according to Test-t applied in both techniques. The figure 1 presents images according to the algorithm execution sequence.

It is worth reminding that the area evidenced through Image J is manually performed, and takes a long time until it comes to the final results. The results were analyzed by a medical area specialist, who verified the concordance of results obtained.

4. Conclusions

Both technique presented satisfactory results in the measurement of total area, granulation and slough, being considered as adequate for the dynamic-therapeutic evaluation of leg ulcers.. The t-student test at 95% was applied and the results confirmed the efficiency of both methods. This finding testifies that the variation observed between the results obtained through both techniques is acceptable and that they can be applied in practice.

This project encourages and contributes for the application of new technologies and hence the use of softwares in this area with the emergence of new research lines. Artificial Neural Networks seem to be a high-level methodology for the analysis of images due to the lower interference from the operator/researcher, since it does not require manual design.

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