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Human footprint Segmentation using Multilayer Perception

KEYWORDS: Multilayer Perception, Foot-print, Bayesian regularization and Metamerism

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ABSTRACT *In this paper, an application of digital image processing and new approach for solving the problem of segmenting the foot print in the color images to be discussed, this can be useful in healthcare domain to predict some major disease for human being. The application is an image processing system, which works on the basis of medical footprint. The image of human foot is input to the system. It is shown that multiplayer perceptron trained with Bayesian regularization back propagation allows to adequately classify the pixels on the color image of the footprint and in this way, to segment the footprint without fingers.*

1. Introduction

1.1 Image Processing and Analysis

Digital computer can perceive the image by mean of sensors, and analyze it by mean of microprocessor. The techniques used to provide perception to digital computer are called image processing and analysis techniques. An image may be defined as a two dimensional function, f(x,y), where x and y are spatial (plane) coordinates, and the amplitude of f at any pair of coordinates (x,y) is called the intensity or grey level of the image at that point. [1]. When x, y and the amplitude values of f are infinite, we call the image an analog image. When these values are finite, discrete quantities, we call the image a digital image.

1.2 Foot-Print

When the foot is planted, not all the sole is in contact with the ground. The footprint is the surface of the foot in contact with the ground. The characteristic form and zones of the footprint are shown in the figure 1(a). Zones 1, 2 and 3 correspond to regions in contact with the surface when the foot is planted these are called anterior heel, posterior heel and isthmus respectively. Zone 4 does not form part of the surface in contact and is called footprint vau1t [2]. These footprints play a key role in the detection of different foot's diseases. To visualize the foot print, an instrument called podoscope is commonly used. This instrument can visualize the footprint based on the optic principle [6] or based on electronic pressure-based sensors [7].

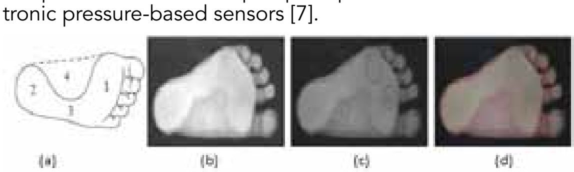

Figure 1. Zones and Images of Foot Plant

2. Methodology

A segmentation based on gray scale is not adequate to separate the pixels of the footprint from the rest of the image by a simple threshold method because of metamerism problem in gray scale images. Metamerism is a phenomenon for greyscale images, where pixels with different values in the color image have associated the same value in the gray-scale image.

2.1 Foot print segmentation using Multilayer Perceptron (MLP)

Figure 1(b) shows a grey-scale image of a footprint. The metamerism effect is shown in figure 1(c): the circles show the footprint and vault pixels with a similar grey level, but with different colors in the image in figure 1(d). Other problem with this type of images in gray scale is the existence of limit zones between the footprint and the vault with low contrast, which make difficult to segment the footprint by using the information provided by the color image.

The neural network has three inputs corresponding to the RGB coordinates of the particular color. The one from the image background, the one from the vault and the one from the footprint. The network has an output assuming the value 1 for background pixels, 0 for the footprint and -1 for the vault. The training set considers 709 samples selected from just one image, the 26% correspond to the background, 38% to the vault and 36% to the footprint. The size of each sample image is 434x342 pixels. The training of the multi-layer perceptron has the following characteristics

- A hidden-layer MLP was used.
- Number of inputs 3
- Number of outputs 1
- A Bayesian regularization back propagation as training algorithm
- Learning in batch modality where weights are updated at the end of each stage.
- The initial network weights were generated by the Nguyen-Widrow method [4] because it increases the convergence speed of the training algorithm [3].
- The initial regularization parameters a and b were 0 and 1 respectively.
- Successive trainings were done increasing progressively the amount of neurons in the hidden layer.

Figure 2 shows the classification results. The classification errors in the footprint edge can be improved by carefully choosing with more detail the training set in the zone. Because the detection of pathologies related to the footprint shape requires the capture of the footprint without toes, the previous result is improved by smoothing the footprint and by eliminating the toes.

Figure 2. Sole Image Classification

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3. Result and Discussion

The improvement steps are the following

1. Binarization
2. Footprint erosion in order to disconnect the toes if it is necessary
3. Smoothing of the footprint by median filter or a low pass filter in the frequency domain
4. Discharging the toes by ticketing and segmentation by size
5. Image dilation in order to recover the size.

The techniques previously noted are described in [5]. To visualize the improvements, the binarization is shown in the figure 3(a), erosion is shown in figure 3(b), toe elimination is shown in figure 3(c), smoothing is shown in figure 3(d), dilation in figure 3(e), and the final result of the surrounding over the color image in figure 3(f).

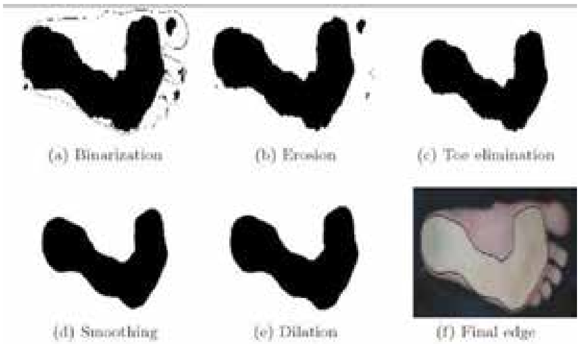

Figure 3. Improvement in the footprint segmentation

S. no	Size of Images	Different Colors	Pixels bad classified	Percent pixels good classified
1	324x139	12518	1927	95,94
2	260x112	8741	1000	96,56
3	260x115	8567	1335	95,46
4	268x121	10008	1304	95,97
5	280x118	10626	1029	96,87
6	300x138	13062	1515	96,34
7	280x118	7586	1005	96,96
8	264x113	9903	709	97,62
9	260x118	8244	1335	95,58
10	294x124	10492	1337	96,25

Table 1. Quality Assessment of the Segmentation

In order to assess the quality of the segmentation carried out by the MLP, a human-assisted segmentation was carried out for 10 footprint images and they are compared with ones obtained by MLP. The results of such comparison are given in the table 1, also the human segmentation of the footprint, the segmentation done by MLP and its errors are shown in figure 3. The figures show that the classification errors are concentrated in the borders. It must be noted that the footprint edges are not well defined and there is a small transition zone, where it is not possible to have a perfect human segmentation. It is possible to improve these results by using a training set with more samples corresponding to the edge zone. It is important to remark that the error introduced by the presence of toes is completely eliminated by the process described in the previous section.

Figure 4. Segmentation Quality

4. Conclusion

This article has based on MLP for the footprint segmentation in color images. The results of this study are promising and they have established a very simple and fast method for footprint automatic detection with no toes. It is foreseen on the near future the development of an automatic and real time diagnosis system of pathologies related with the footprint shape.

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