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Evaluation of wound healing process based on texture analysis

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ABSTRACT

The proposed work is to study a standardized and objective technique to assess the progress of wound healing in foot by means of texture analysis. The methods of image pre-processing, segmentation and texture analysis together with visual expert's evaluation were used to assess the wound healing process. The images were intensity normalized, and wounds were automatic segmented using a snake's segmentation system. We found texture characteristics that may indicate the progression of wound healing process. More specifically, some texture features increase (mean, contrast), while some other texture features decrease (entropy, sum of squares variance, sum average, sum variance) with the progression of the wound healing process. Some of these features were found to be significantly different in a specific time point and this could be used to indicate the rate of wound healing. No significant differences were found for all geometrical measures. The results of this study suggest that some texture features might be used to monitor the wound healing process, thus reducing the workload of experts, provide standardization, reduce costs, and improve the quality for patients. The simplicity of the method also suggests that it may be a valuable tool in clinical wound evaluation.

Key words: WHS, MAVIS System, RGB and Snakes Segmentation.

INTRODUCTION

Chronic wounds present an increasing health challenge as the population ages and the incidence of different chronic diseases grows worldwide. The progress of wound healing may be quantified by the rate of change of the wound's surface area. However, this is a challenging task due to the complexity of the wound, the variable lighting conditions, and the time constraints in clinical laboratories (1, 5). One way to evaluate wound healing rate is to monitor wound status by taking images of the wound at regular patient visits. If the physical dimensions of the wound are assessed at regular time intervals, then the experts will know if the patient is responding well or not to a particular treatment and if necessary change it. In 2012 the 22nd annual meeting of the Wound Healing Society (WHS), set the standards for wound healing procedures and proposed recommendations for evaluating the optimal wound treatment. In [2], the authors proposed and evaluated an algorithm for the wound segmentation with minimal manual input and a high accuracy, which uses a combination of both RGB and L*a*b* color spaces, as well as a combination of threshold and pixel-based color comparing segmentation methods.

Jones et al., and Jones, developed the MAVIS system, which is able to automatically measure the dimensions of skin wounds. Their method was based on color segmentation algorithms and was able to segment an image into one of three tissue types: healthy skin, wound tissue and epithelialisation tissue (3). Furthermore, six measurement parameters: the R, G and B color planes, hue, saturation and gray-level intensity were taken into consideration. The R, G and B color planes were only examined in isolation showing that straightforward thresh holding of color planes

cannot produce a good segmentation which distinguishes between wound and skin tissues. They found that wound segmentation is only partially succeeded, if only the 1D color histograms were taken into consideration, while using a 3D RGB histogram space, the color volume clusters may be more widely separated and a better segmentation result can be achieved (4-5). Mekkes et al. made some progress with such the 3D RGB color histogram clustering technique to assess the healing of wounds. It was shown that clusters in RGB space for a given tissue type formed an irregularly shaped 3D cloud, and so simple thresh holding along the R, G and B axes would not help to segment the image into these three tissue types (6). Some other researchers presented their techniques on the segmentation of wounds in color images based on the use of the black-yellow red classification scheme to evaluate the debridement activity of wounds. A method to correct for limb convexity in color video images in order to measure the size of skin wounds and ulceration was presented, while techniques to evaluate wound repair in humans and animals using basic color image processing were proposed (7-9). In a Support Vector Machine classifier (SVM), was employed to perform region segmentation of the wound tissue followed by extraction of the wound contour. The authors, used 50 RGB images manually delineated by experts as training data, and then tested their method using 23 new RGB wound images Their SVM algorithm was able to correctly classify roughly 94% of the pixels as either wound or non-wound, compared with professional tracings (10, 11).

Formulation containing neomycin and ghee was evaluated for wound-healing potential on different experimental models of wounds in rats (19). The rats were divided into six groups of group 1 as control, group 2 as treated with neomycin only, group 3 as treated only with ghee, group 4 treated with F-1 formulation containing ghee 40% and neomycin 0.5%, group 5 treated with F-2 formulation containing ghee 50% and neomycin 0.5% and group 6 treated with F-3 formulation containing ghee and ointment base in all two wound models, each group consisting of six rats. Wound contraction ability in excision wound model was measured at different time intervals and study was continued until wound is completely healed (12, 13). Tensile strength was measured in 10-day-old incision wound and quantitative estimation of hydroxy proline content in the healed tissue was determined in 10-day-old excision wound (13, 15). Histological studies were done on 10-day-old sections of regenerated tissue of incision wound. F-2 formulation containing ghee 50% and neomycin 0.5% showed statistically significant response, in terms of wound contracting ability, wound closure time, period of epithelization, tensile strength of the wound, regeneration of tissues at wound site when compared with the control group and these results were comparable to those of a reference neomycin ointment (12, 13, and 17).

Motivation

Wound healing rate, remains an interesting and important issue, in which modern imaging techniques have not yet given a definitive answer. In order to guide better therapeutic interventions, a better understanding of the fundamental mechanisms driving tissue repair are required. Also there are not many research groups worldwide that are involved in color image processing of wounds (16, 18).

Proposed Method

Snakes Segmentation: The Williams & Shah snake segmentation method was used to deform the snake and segment the final wound borders which is given by the negative gradient of the current contour point proposed. For the calculation of the snake start the snake deformation, this is consistent with other studies. The extracted final snake contours are shown. The proposed snakes' segmentation method was proposed and evaluated, in 100 ultrasound images of the common carotid artery (CCA) and more details about the model can be found there (14).

Texture and Morphological Features: In this study the following texture features, and geometrical measures were extracted from all segmented wounds:

- **Statistical Features (SF)**:

1) Mean, 2) Standard Deviation, 3) Median value, 4) Skewness, 5) Kurtosis, and 7) Entropy.

- **Spatial Gray Level Dependence Matrices (SGLDM)** as proposed by Haralick *et al*. 1) Contrast, 2) Sum of Squares Variance (SOSV), 3) Inverse Difference Moment (IDM), 4) Sum Average (SA), 5) Sum Variance (SV), 6) Sum Entropy (SE), 7) Entropy, 8) Difference Variance (DV), and 9) Difference Entropy (DE).
- **Geometrical measures:** 1) Area, 2) Perimeter, 3) X co ordinate length, and 4) Y-coordinate length. Each feature was computed using a distance of one pixel (16, 20).

CONCLUSION

Accurate wound assessment is a critical task for patient care and health cost reduction at hospital but even still worse in the context of clinical studies in laboratory. This task, completely devoted to nurses, still relies on manual and tedious practices. Wound shape is measured with rules, tracing papers or rarely with alginate castings and serum injection. The wound tissues proportion is also estimated by a qualitative visual assessment based on the red-yellow-black code. We demonstrate that, in this context, a simple active contour method can successfully replace more complex tools such as SVM supervised classification, as no training step is required and that one shot is enough to deal with perspective projection errors. Moreover, involving all the spectral response of the tissue and not only RGB components provides a higher discrimination for separating healed epithelial tissue from granulation tissue.

A comparative preclinical study was conducted in the context of apitherapy where RGB and multispectral images were processed in order to analyze wound healing evolution. Furthermore, we noted that multispectral imaging enables a deeper analysis of wound images where epithelial tissue can be clearly discriminated from granulation tissue, which is not the case with RGB imaging. In medical field, this study demonstrated that medical thyme honey is a relevant low cost alternative to commercial wound care products. Further experiments will be planned on three pigs with a new version of the prototype in order to validate the reproducibility of the experimental results and to enable full matching between colour and multispectral data.

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REFERENCES

[1] A.J.M. Boulton, L. Vileikyte, G. Ragnarson-Tennvall, J. Apelqvist, *Lancet*, vol. 366, pp. 1719–1724,**2005**.
[2] E.S. Papazoglou, L. Zubkov, X. Mao, M. Neidrauer, N. Rannouy, M.S. Weingarten, *Wound Rep. Reg.*, vol. 18, pp. 349–358, **2010**.
[3] J. Whitney, L. Phillips, R. Aslam, A. Barbul, F. Gottrup, L. Gould, M.C. Robson, G. Rodeheaver, D. Thomas, N. Stotts, *Wound Rep. Reg.*, vol. 14, pp. 663–679, **2006**.
[4] B.F. Jones, P. Plassman, *IEEE Trans. Biomed. Eng.*, vol. 42, no. 5, pp. 464-470, **1995**.
[5] T.D. Jones, "Semi-automatic segmentation algorithms for measuring the area of skin wounds, University of Glamorgan, Department of Computer Studies, Computer Studies Technical Report CS-94-3, **1994**.
[6] J.R. Mekkes, W. Westerhof, *Clinics Dermatol.*, vol. 13, no. 4, pp. 401-407, **1995**.
[7] S. el Gammal, R. Popp, *Skin Resear. Techn.*, vol. 1, no. 3, pp. 158, **1995**.
[8] C. Solomon, A.R. Munro, A.M. van Rij, R. Christie, *British J. Dermatol.*, vol. 133, pp. 565-570, **1995**.
[9] D.J. Smith, S. Bhat, J.P. Bulgrin, *Wounds*, vol. 4, no. 1, pp. 6-15, **1992**.
[10] M. Kolesnik, A. Fexa, "Segmentation of wounds in the combined colortexture feature spapce", *Proc. SPIE: Med. Imag.*, San-Diego, USA, vol. 5370, pp.549-556, 16-19 Feb. **2004**.
[11] V. Vapnik, "The Nature of Statistical Learning Theory", Springer, New York, **1995**.
[12] B. Acha, C. Serrano, J.I. Acha, L.M. Roa, *J. Biomed. Opt.*, vol. 10, no. 034014, pp. 1–11, **2005**.
[13] N. Otsu, *IEEE Trans. Syst. Man. Cy.*, vol. 1, no. 9, pp. 62-66, **1979**.
[14] D.J. Williams, M. Shah, *Int. J. Graph., Vision and Imag. Proc.: Image Underst.*, vol. 55, pp. 14-26, **1992**.
[15] C.P. Loizou, C.S. Pattichis, M. Pantziaris, A. Nicolaides, *IEEE Trans. Inform. Techn. Biomed.*, vol. 11, no. 6, pp. 661-667, Nov. **2007**.
[16] R.M. Haralick, K. Shanmugam, I. Dinstein, *IEEE Trans. Systems, Man., and Cybernetics*, vol. SMC- 3, pp. 610-621, Nov. **1973**.
[17] J.M. Bland, D.G. Altman, *Lancet*, vol. 1, no 8476, pp. 307–310, **1986**.
[18] G. Gethin, *Wounds*, vol. 2, no. 2, pp 60-68, **2006**.
[19] M. Flanagan, *J. Wound Care*, vol. 12, no. 5, pp. 189–194, **2003**.
[20] H. Oduncu, A. Hoppe, M. Clark, R.J. Williams, K.G. Harding, *Int. J. Low Extrem. Wounds*, vol. 3, no. 3, pp. 151-156, **2004**.