Abstract

Chronic ulcer (CU) is a clinical condition characterised by localized injury to the skin, with its tissues having physiologically impaired healing response. The common causes of the ulcers are old age, immobility, arterial and venous insufficiency, diabetes and adverse effect of corticosteroids. CU affects patients globally and poses significant burden on the health-care system. Characterising wound area and underlying tissues can be significant predictor for wound healing. Therefore, precise measurement of these prognosticators becomes essential in monitoring the healing process of CUs and assessment of therapeutic prognosis. Quantitative assessment of CUs can be potential bedside tool that can be employed for combating traditional dermatology problems.

This dissertation presents a non-invasive and automated ulcer periphery detection technique using digitally captured images by a hand-held optical camera. The approach involves spectral clustering and gray based fuzzy spectral clustering for generating the similarity measure using spatial knowledge of an image. Firstly, the illumination in an optical image is made homogeneous using a quadratic approach of color constancy. In the next step, spurious regions were delineated by applying the first-order filter locally. The filter was chosen based on seven image quality measures. Finally, the best color channel was selected by calculating the mean contrast for 26 different color channels of 14 color spaces. It was found that Db channel had highest mean contrast, which was subsequently used as working color channel for segmentation. The performance of proposed segmentation technique was confirmed by ground-truth images labelled by dermatologists. It was found that fuzzy spectral approach was the best for delineating the wound periphery. The performance of the proposed method shows its robustness for measurement of ulcer perimeter and healing progression.

Ulcerous tissue composed of granulation, necrotic and slough tissue compositions, which are mainly visualized by color. In conventional practice, the dermatologists evaluate various ulcers and their healing conditions based on the color differentiation of these aforementioned tissue types. Such visual assessment is obviously time consuming and error-prone. In order to quantify the percentage of tissue types present in ulcerous region, a computerized automated tissue classification framework has been established in this thesis using color as well as texture features of tissue composition. Here, feature set was developed by extracting various textural features (19 Gray level concurrence matrix

based, 44 Gray Level Run Length Matrix based, 12 local binary patterns, and a fractal dimension) and 13 color statistics. Three classification techniques viz., classification and regression tree (CART), back propagation neural network and random forest were considered here. Based on their performance evaluation, random forest was found to be the best model having 98.94% average accuracy and 97.18% sensitivity. The developed automated tissue classification framework will be the value addition to the conventional practice in terms of augmenting the CU assessment accuracy more efficiently and providing dermatological screening/monitoring under tele-wound network.

Keywords: Chronic ulcer, digital image processing, pre-processing, spectral based segmentation, supervised tissue classification,