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Boundary Detection of Skin Cancer Lesions Using Image Processing Techniques

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ABSTRACT:

Among all types of cancers affecting humans, the incidence of skin cancer is increasing by manifolds which may be associated with exposure to UV light, fairness of skin, older age, and many other factors. In the medical research area, a major focus remains to diagnose cancers at their earliest for providing the treatment before the disease reaches its non-curable stage. A diagnostic approach that is non-invasive with least amount of discomfort to the person under investigation becomes of paramount interest. Thermography is one such technique that has potential to identify skin lesions that are malignant with the help of their temperature readings. This work focuses mainly on edge detection of malignant skin lesions. For the same purpose, edge detection algorithms have been used to detect border of skin cancer lesions from their thermal images. While some algorithms could not yield expected results, other methods exhibited potential to highlight the lesion border and so these methods could be further optimised to achieve better results.

KEYWORDS:

Digital infrared imaging, thermography, skin cancer, edge detection, tumor boundary detection.

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INTRODUCTION:

In the United States and United Kingdom, The most common type of carcinoma is skin cancer[1, 2]. In US alone, the number of people diagnosed with skin cancer is more than 3 million [1] with more people being diagnosed with skin cancer as compared to all the cancer types together [2].From the three types of skin carcinoma, Melanoma is the most fatal [3].

Recently there is a growing trend for non-invasive diagnosis and simple devices are being made for the same [4,5]. Thermography technique is widely being used in the area of biomedical research as it is completely harmless, non-invasive and viable option that is showing promise as a reliable diagnostic technique for a range of diseases that are associated with changes in the body temperature from its normal range.The cancerous lesion on skin gets warmer as a result of angiogenesis [6] and thermal images can provide their temperature mapping which helps to identify such warmer regions of skin. Image processing has been extensively used in medical diagnosis [7-9].

As it is known that a usual and obvious marker for skin cancer is the presence of lesions over the skin surface (which may not always be the case), it makes lesion boundary detection and its study a pertinent part of research as this could lead to understanding of tumour development and growth pattern.

Extraction and analysis of objects from medical images is often used as a means of disease identification [10, 11]. An edge or border in an image is characterised by acute change in colour, depth, and other factors [12]. In case of thermal images, a body is represented in terms of the radiations it emits which are depicted using various colours and therefore an important criterion for edge detection is change in colour intensity. As colour is a major parameter that helps to study and analyse thermal images, this makes edge detection from thermal images a potential area of investigations and research for identification of objects like tumours and lesions from medical images. From image processing point of view, algorithms for boundary identification can be used for attempting to locate the lesion from the thermal image. The procedure for edge detection is an action of identifying major local changes in levels of intensity of an image [13, 14]. Probability-based edge detection techniques are more suitable for outlining

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bodies in medical thermal images as per UI Bajwa et al. [15] while Quming Zhou et al[16] found level set based segmentation method successful in boundary extraction. After a proper edge is detected of the lesion, ROI can be obtained, once ROI is obtained all feature extraction and classification techniques applied in [17-19] can be implemented for understanding the underlying patterns in the thermal images.

MATERIALS AND METHODS:

The platform chosen for medical image processing over the thermal images of skin cancer is ImageJ 1.48V.The experiments were performed on skin cancer thermal images provided by FJ Gonzalez [6]. These thermal images were captured with FLIR T400 Western Camera with the size 320x240.

For the purpose of lesion border identification, Sobel, Canny Edge Detector, Canny-Deriche and Hysteresis thresholdingalgorithms were chosen for experimentation. Specific parameter values to these methods were only provided when needed and as a means for refinement of results. The original image was subjected to these filters without any pre-processing. In the first approach, sobel and canny algorithms were applied directly on colour thermal image. In second approach, as per its requirement, gray scale version of the thermal image was used for applying the Canny-Deriche algorithm. Figure 1 shows the thermal image and figure 2 is the set of resultant imagesafter application of Sobel, Canny and Canny-Deriche edge detection algorithms. In the third approach, a convolve filter was applied on the colour thermal image followed by double thresholding using hysteresis and then conversion to binary for a better visualization of lesion boundary as shown in figure 3.

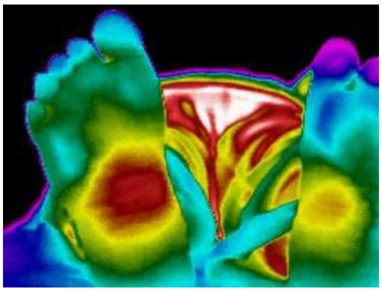

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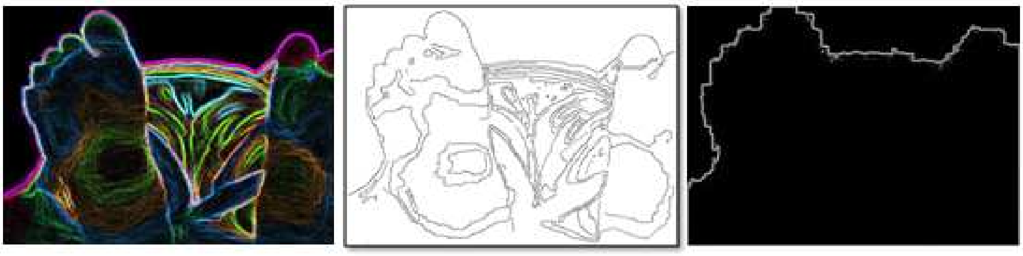
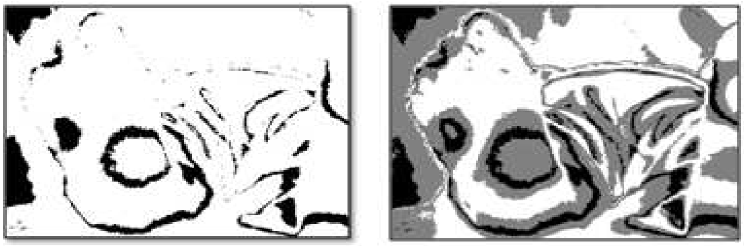
Figure 1: Thermal image with lesion on the patient's right foot (seen in red colour) [6]

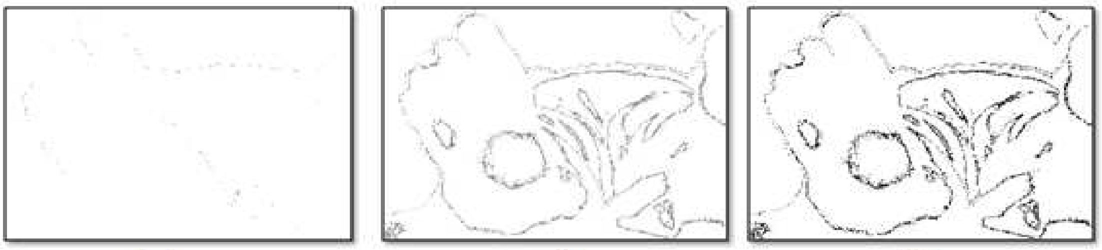


(a) Sobel | (b) Canny | (c) Canny-Deriche



(d) Double Thresholding by Hysteresis | (e) Double Thresholding by Hysteresis (Trinarisation)

Figure 2: Resultant Images after application of four edge detection methods



(a) Double Thresholding by Hysteresis | (b) Double Thresholding by Hysteresis (Trinarisation) | (c) binary conversion of figure 3(b)

Figure 3: Results using the double thresholding method applied after subjecting the thermal image to convolve filter

RESULTS AND DISCUSSION:

While Sobel, Canny, double thresholding (with hysteresis) worked directly on the colour image, Canny-Deriche algorithm required conversion of thermal image to gray scale. The Sobel algorithm with its default values could not yield accurate detection of lesion border. While the visual interpretations lead to immediate discarding of Canny-Deriche algorithm due to its highly unsuccessful results (in case of identifying skin cancer lesions from a thermal image), other approaches like Canny edge detection, double thresholding (by hysteresis) and convolve filter coupled with double thresholding (by hysteresis) were close to border identification.Also, Canny edge detector is capable of detecting true edge points with least amount of error [16].

CONCLUSION:

Edge detection in case of medical images is one area that is still in progress with researchers presenting newer and more novel methods for correct identification of object border in medical images. The border identification for skin cancer lesions could be much useful in studying the lesion formation and its subsequent growth pattern. In this work some edge detection algorithms were taken into account for identifying skin cancer lesions from thermal images. Optimal edge detection method like Canny was found to be useful as compared with the gradient method like Sobel. With some further optimizations, Canny edge detector, double thresholding with hysteresis hold the potential to further provide results that are closer to correct identification of lesion edge. The availability of larger databases of skin cancer thermal images would also be a paramount factor in cross-validating these conclusions in future research endeavours.

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