Skin Cancer Image Detection using Watershed Marker-Controlled and Canny Edge Detection Techniques

Norhafiza Hamzah#, Mohd Sapaweh Asli, Rechard Lee
Faculty of Science and Natural Resources, Universiti Malaysia Sabah, Jalan UMS, 88400 Kota Kinabalu, Sabah, MALAYSIA.
*Corresponding author. E-Mail: hafiza@ums.edu.my; Tel: +6088-320000; Fax: +6088-435324.

ABSTRACT There are two main types of skin cancer which are melanoma and non-melanoma. This paper proposed a prototype system for detecting melanoma type of skin cancer. The detection system developed in this paper is based on digital images of skin cancer using a combination of watershed marker-controlled technique and canny edge detection technique during image segmentation process. The ABCD (Asymmetry, Border, Colour, and Diameter) method is used to extract the characteristics of the melanoma type of skin cancer on the skin cancer image. The four characteristics of melanoma skin cancer are Asymmetrical shape, Border irregular, Colour variant and Diameter greater than 6mm, which are used by dermatologists to classify melanomas. Several experiments had been conducted to test the accuracy and effectiveness of the proposed system. The experiments are detection test for melanoma skin cancer melanoma and non-melanoma skin cancer image, comparison test for image segmentation techniques, and a detection test using the noised image of melanoma skin cancer. The results show the proposed prototype system is able to detect nine out of ten images of melanoma skin cancer and distinguish eight out of ten for non-melanoma skin cancer images. Combination of the proposed techniques is better compared to the other techniques because of the segmentation techniques used can distinguish between the main object, Region of Interest, as well as the less important object in the image of skin cancer.

KEYWORDS: Skin Cancer; Melanoma; Image Processing; Watershed Marker-Controlled; Canny Edge Detection;

Full Article - *Computer and Information Sciences*
Received 9 January 2018 **Revised** 23 March 2018 **Accepted** 26 March 2018 **Online** 28 March 2018

INTRODUCTION

One of the most significant features of cancer cells is it lose many of the regulatory function present in normal cells (Aziz *et al*., 2015). Skin cancer is a type of disease that grows around human skin. There are two main types of skin cancer, non-melanoma and melanoma where non-melanoma skin cancer is more frequent in patients than melanoma. Based on the statement issued by the World Health Organization (WHO), an estimated 132,000 cancer melanoma occur globally each year and approximately 66,000 deaths were reported.

The existing system for detecting skin cancers only uses image inputs that have many blurring and noise disruption. It is because the equipment cannot produce a good resolution at a less appropriate atmosphere. This will reduce the accuracy of the segmentation process and also affect the second process, classification. There are also some research projects conducted related to an intelligent decision support system for skin lesion recognition to help early diagnosis by using an intelligent agent-based system. Agent technology is a new paradigm suitable for developing such systems that situates and operates in a dynamic and heterogeneous environment (Chin *et al*., 2014).

Image segmentation process, the process of separating skin cancer moles with healthy skin found in skin cancer images is used in developing this type of melanoma skin cancer detection system. Among the image segmentation techniques previously used by the previous researcher are the technique of mining which is a technique based on the pixel equation in the image (Lawand, 2014). In addition, the image grading technique based on gradient (Mahmoud, 2014), a k-min grouping technique that relies on image pixel groups (Thasneem *et al.*, 2015) and watershed techniques based on magnitude gradients in the image (Das and Ghoshal, 2016) was also used by previous researchers.

METHODOLOGY

There are two major processes in the melanoma skin cancer detection system in this paper. The first process is the image segmentation and the second process is the extraction of melanoma skin cancer features as well as classification based on the extracted features. Regional based segmentation is one of the common techniques used to separate or group images into small sections based on the common features of the image (Castillejos *et al.*, 2012).

Image Segmentation

Image segmentation steps using marker-controlled watershed algorithm and Canny edge detection:

i. Read the colour images (RGB) and replace the colour space of the image to the grayscale.
ii. Using magnitude gradients as a segmentation function.
iii. Generate markers for image backgrounds.
iv. Use the segmentation function for watershed transformation.
v. Use the Canny edge detection technique to draw the boundary between the foreground and the background.

Feature Extraction and Classification

Four features of melanoma skin cancer are extracted in the image of skin cancer using the ABCD rule:

i. Asymmetry; in which the moles found on the image of skin cancer is not equal when halved.
ii. Border; the irregular border of the moles.
iii. Colour; the moles' colours are combination of white, black, red, bright brown, dark brown and, or bluish grey.
iv. Diameter; the mole diameter when it exceeds 6mm.

Asymmetry calculation is based on the following equation:

$$AI = \frac{A1 + A2}{2} \tag{1}$$

where $A1$ and $A2$ is overlapping image area for x and y axis. For the border calculation, following equation will be used:

$$VI = \frac{Max \cdot Min(\text{mod}\, 6) + 2}{100} \tag{2}$$

where *Min* and *Max* are the lengths for image's x and y axis, 6 is the average diameter of the mole, and the geometry shape index is 2. This is the image pre-processing step to get the fixed shape of the mole before the colour feature extraction can be made. For colour presence, Compact Index is calculated using the length of each colour, L and the total number of pixels in Region of Interest (ROI), N where:

$$CI = \frac{L(Pixel)}{N} \tag{3}$$

Then, the diameter of ROI is evaluated with p represents the pixel with the longest diameter in the ROI using the following rules:

$$D = \begin{cases} \geq 6mm\, if \;\; p = 23.6772 \\ < 6mm\, if \;\; p < 23.6772 \end{cases} \tag{4}$$

The classification process is based on the four calculations above, which is in the form of Total Dermoscopic Score (TDS) as follows:

$$TDS = (1.3 \times A1) + (0.1 \times VI) + (0.5 \times CI) + (0.5 \times Dia) \tag{5}$$

In the process of classification, skin cancer image inputs will be determined whether they are melanoma or other skin cancer. The determination is based on the calculated TDS value by referring to the interpretation by Stolz *et al*., (1994) shown in Table 1.

Table 1. Classification of skin cancer image based on TDS.

Total Dermoscopy Score (TDS)	Interpretation
< 4.75	Benign melanocytic lesion
4.8-5.45	Suspicious lesion; close follow up or excision recommended
> 5.45	Lesion highly suggestive of melanoma

RESULT AND DISCUSSION

Images of melanoma and non-melanoma skin cancer are used as inputs for accuracy test. 9/10 images of melanoma skin cancer can be detected, and 8/10 non-melanoma images can be distinguished by the developed prototype. Table 2 is an example of detectable and undetectable image of melanoma and non-melanoma skin cancer images.

Table 2. Output classification of melanoma and non-melanoma skin images.

Input Image	TDS value	Classification Output
Melanoma		
	5.46	Accurate
	5.00	Inaccurate
Non-melanoma		
	4.75	Accurate
	6.04	Inaccurate

Among the factors that can cause the detection to be inaccurate are the features that are supposed to exist in melanoma skin cancer can't be detected or absent on the image. As shown in Table 2 for Melanoma input image, asymmetrical feature in second image is undetectable, because when the ROI on the image is equally split by two, both parts are almost symmetry. Another factor is the image of non-melanoma skin cancer that has one or more properties possessed by melanoma skin cancer, as shown by the second image in Table 2, has irregular border features which are similar to characteristics of melanoma skin cancer.

CONCLUSION

The results show that the prototype developed can detect 9 of the images of melanoma skin cancer and differentiate 8 of the images of non-melanoma skin cancer for 10 tested images. Additionally, segmentation comparison tests suggest that the proposed marker-controlled watershed and Canny edge detection techniques have some advantages over other segmentation techniques. This segmentation technique can distinguish ROI as well as less important objects in skin cancer images.

ACKNOWLEDGEMENTS

This research is supported by the Research Acculturation Collaborative Effort research grant RACE0017-ST-2014 by Ministry of Higher Education Malaysia.

REFERENCES

[1] Aziz, A., Abu Bakar, M. A., & Mohd Yusof, F. Z. (2017). Concentration and Time Dependent Cytotoxic effect of Methanolic Crude Extracts of Pseuduvaria macrophylla on the Human Cancer Cell Line. *Transactions on Science and Technology*, **4**(4), 489 – 497.

[2] Castillejos, H., Ponomaryov, V., de-Rivera, L.N. & Golikov, V. (2012). Wavelet Transform Fuzzy Algorithms for Dermoscopic Image Segmentation. *Computational and Mathematical Methods in Medicine*, **2012**(2012), 41–52.

[3] Chin, K. O., Gan, K. S., Alfred, R., Anthony, P., & Lukose, D. (2014). Agent Architecture: An Overview. *Transactions on Science and Technology*, **1**(1), 18 - 35.

[4] Das, A. & Ghoshal, D. (2016). Human Skin Region Segmentation Based on Chrominance Component using Modified Watershed Algorithm. *Proceedings of 12th International Multi-Conference on Information Processing (IMCIP-2016)*. 19 August, 2016. Bangalore, India. pp 1-2.

[5] Lawand, K. (2014). Segmentation of Dermoscopic Images. *IOSR Journal of Engineering*, **4**(4), 16-20.

[6] Mahmoud., M. K. A. (2014). *Improving Skin Cancer (Melanoma) Detection: New Method*. PhD Thesis, University of Technology Sydney, Australia.

[7] Stolz W, Riemann A, Armand B, Cognetta AB, Pillet L, Abmayr W. (1994). ABCD rule of dermatoscopy: a new practical method for early recognition of malignant melanoma. *Eur J Dermatol* 4(7), 521-527.

[8] Thasneem, A. A. H., Mehaboobathunnisa R., Mohammed, S. M. & Arumugam, S. (2015). Comparison of Different Segmentation Algorithms for Dermoscopic Images. *ICTACT Journal on Image & Video Processing*, **5**(4), 1030-1036.