ABCD FEATURE EXTRACTION OF IMAGE DERMATOSCOPIC BASED ON MORPHOLOGY ANALYSIS FOR MELANOMA SKIN CANCER DIAGNOSIS

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Abstract

This research present asymmetry, border irregularity, color variation, and diameter (ABCD) feature extraction of image dermatoscopic for melanoma skin cancer diagnosis. ABCD feature is the important information based on morphology analysis of image dermatoscopic lesion. ABCD feature is used to calculate Total Dermatoscopic Value (TDV) for melanoma skin cancer diagnosis. Asymmetry feature consist information of asymmetry and lengthening index of the lesion. Border irregularity feature consist information of compactness index, fractal dimension, edge abruptness, and pigmentation transition from the lesion. Color homogeneity feature consist information of color homogeneity and the correlation between photometry and geometry of the lesion. Diameter extraction is diameter of the lesion. There are three diagnosis that is used on this research i.e. melanoma, suspicious, and benign skin lesion. The experiment uses 30 samples of image dermatoscopic lesion that is suspicious melanoma skin cancer. Based on the experiment, the accuracy of the system is 85% that there are four false diagnoses of 30 samples.

Keywords: *asymmetry, border irregularity, color variation, feature extraction, melanoma*

Abstrak

Penelitian ini menyajikan ekstraksi fitur citra dermatoskopik untuk diagnosis kanker kulit melanoma berdasarkan *asymmetry*, *border irregularity*, *color variation*, dan *diameter* (ABCD). Fitur ABCD adalah informasi yang penting berdasarkan analisis morfologi lesi citra dermatoskopik. Fitur tersebut digunakan dalam perhitungan *Total Dermatoscopic Value* (TDV) untuk diagnosis kanker kulit melanoma. Fitur *asymmetry* terdiri dari informasi asimetri dan indeks perpanjangan luka. Fitur *border irregularity* terdiri dari informasi indeks *compactness*, dimensi fraktal, *edge abruptness*, dan transisi pigmentasi dari lesi. Warna fitur homogenitas terdiri dari informasi homogenitas warna dan korelasi antara fotometri dan geometri lesi. Ekstraksi diameter adalah diameter lesi. Ada tiga diagnosa yang digunakan pada penelitian ini yaitu melanoma, diduga melanoma, dan *benign skin lesion*. Percobaan ini menggunakan 30 sampel dari lesi citra dermatoskopik kanker kulit melanoma yang mencurigakan. Berdasarkan percobaan, akurasi dari sistem ini adalah 85% dan terdapat empat diagnosa palsu dari 30 sampel.

Kata Kunci:*asimetri,border irregularity, ekstraksi fitur, melanoma, variasi warna*

1. Introduction

Malignant melanoma is the most dangerous human skin disease. It is the deadliest from of all skin cancers and arises from cancerous growth in pigmented skin lesion. If early recognized, the melanoma can be removed and the patient can be recovered completely [1]. More early diagnosis of malignant melanoma is a crucial issue for the dermatologists. The list of specify visual features associated with malignant lesions symptoms. Unfortunately, it can be difficult to interpret visually features and then to recognize malignant pigmented lesion. Even experienced dermatologists have difficulties for distinguishing melanoma from other pigmented lesion of the skin, such as typical whose are benign [2].

This problem raises an interest dermatologist that allows ease of clinical recognition of melanoma, including automatic interpretation of color images dermatoscopic with computerized image analysis. That way, there are interesting developments of the computer system aids (computer-aided systems or CAD) for the clinical diagnosis of melanoma as a support for dermatological experts in different analysis steps, such as the detection limit of injury, the calculation of diagnostic features, classification of

the types of injuries difference, visualization, and others.

Stages of the process of melanoma skin cancer diagnosis are preprocessing, segmentation, ABCD feature extraction from the lesion, and the calculation of Total Dermatoscopic Value (TDV). Preprocessing and segmentation research has been done by Chastine, et al [3]. This study covers ABCD feature extraction method of object segmentation result that suspected melanoma lesion to get information whether the injury is non-melanoma or melanoma.

ABCD feature is the important information based on morphology analysis of image dermatoscopic lesion. ABCD feature is Asymmetry, Border Irregularity, Color Variation and Diameter features. The melanoma lesions usually have morphology characteristics such as asymmetrical characteristic, irregular edge of the lesion, different color composition, and a large diameter. Asymmetry feature consist information of asymmetry and lengthening Index of the lesion.Border Irregularity feature consist information of Compactness Index, Fractal Dimension, Edge Abruptness, and Pigmentation Transition from the lesion. Color homogeneity feature consist of Color Information Homogeneity and the correlation between Photometry and Geometry of the lesion. Diameter extraction is diameter of the lesion.

The rest of the paper is organized as follows; Section 2 describes architecture of the system and describes method of ABCD feature extraction. Section 3 describes about the experimental result and evaluation performance, and section 4 describes conclusion of this research.

2. Methodology

Dermatologists generally use slides as image storage and benchmarking visual lesion. Each image has one or more lesion that is located in normal skin with a variety of colors. Lesion is varied in sizes, shapes, colors, and saturations. Figure 1 shows the four types of lesion, i.e. a and b is benign nevus, c and d is malignant melanoma [1]. Preprocessing steps required to improve the quality of the image. Consisting of noise reduction and improve hand-side edge to distinguish the area around the lesion with skin.

All of the process of melanoma skin cancer diagnosis is described on architecture system in figure 2. The preprocessing and segmentation process are previous research [3]. This paper present ABCD feature extraction, compute Total Dermatoscopic Value (TDV) and melanoma skin cancer diagnosis.

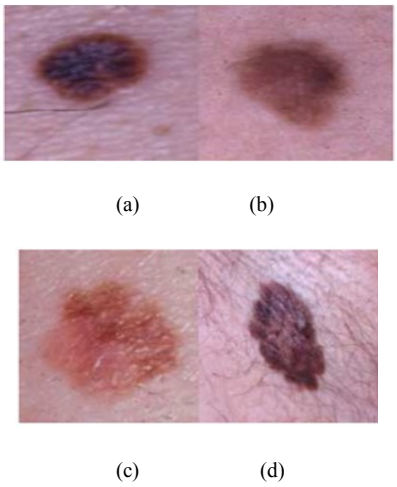


Figure 1.Colour images of lesions,a and b: benign nevus, c and d: malignant melanoma [1].

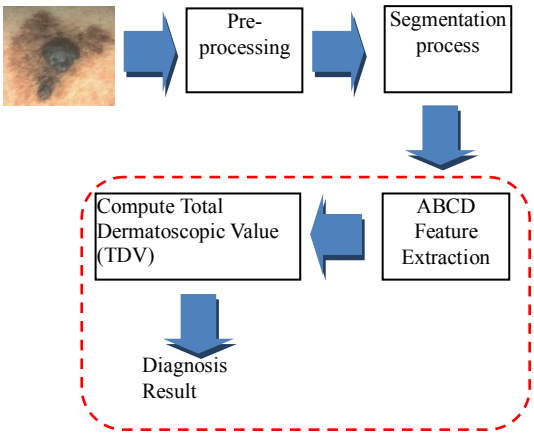


Figure 2.Architecture system of melanoma skin cancer diagnosis.

In this research, method of preprocessing for smoothing image from noise is median filtering. Median filtering is used for minimizing the influence of small structures like thin hairs and isolated islands of pixels like small air bubbles.The median filteris a non-linear digital filtering technique, often used to remove noise from images or other signals. Median filtering is a common step in image processing. It is particularly useful to reduce speckle noise and salt and pepper noise.

Segmentation aims to select and isolate (separate) objects from an overall image.Segmentation consists of down sampling, filtering, and edge detection. Down sampling stage is a process to decrease the number of pixels and eliminate some of the information from the image. With a fixed image resolution, down sampling the image size is smaller [4].

There are two steps of segmentation process are fuzzyset and region growing. Region growing is an approach to determine which neighborhood pixels from a seed and determine whether a pixel added to the seed or not. The principle of this method is determining the first set of seed point then initialized a region of the seed. Region will continue to grow from seed point into the points close together depending on the criteria. Criteria are usually made based on the specified gray level, intensity, or color.

Region growing is a segmentation technique that gathers the pixels into a homogeneous region according to a similarity criterion. This algorithm requires a seed pixel that lies inside the ROI and threshold θ as a stopping condition. It starts with the seed pixel which represented by the first approximation of the ROI.Four connected neighboring pixels that are above the threshold are labeled as one; these neighbors of these pixels areinspected and the procedure continues.

If the connected pixels is less than the threshold, it is labeled as zero, indicating a boundary pixel, and its neighborhood are not processed. The recursive process continues until all the connected pixels fail the test of inclusion in the region.In order to optimize the results of the region growing, it selects the center of a homogeneous area as the seed pixels.

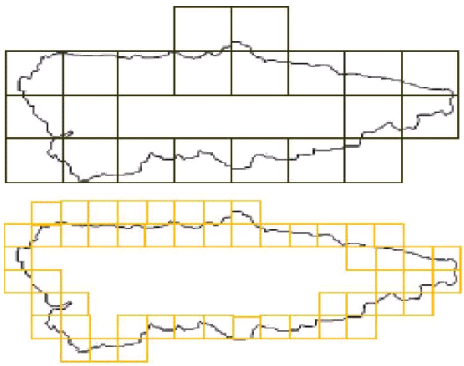


Figure 3.Metode box-counting.

ABCD feature extraction is one of the process to extract the important feature. The results of this process are used to distinguish melanoma or non melanoma. There are four important features i.e. Asymmetry, Border Irregularity, Color Variation, and Diameter.

First, Asymmetry feature. There are two value of asymmetry feature i.e. Asymmetry Index (AI) and Lengthening Index. Asymmetry Index value is computed with the equation 1:

$$AI = \frac{1}{2}\sum_{k=1}^{2} \frac{\Delta Ak}{A_L}, \qquad (1)$$

Where k is mayor and minor axis, $\Delta A_k$is non-overlapping area of lesion.

Lengthening Index is used to describe the elongation of a lesion, for example the degree of anisotropy lesion. Elongation injury is related to eigenvalue λ', λ"from the inertia tensor matrix. This is defined by the ratio of moment of inertia λ'about the major axis using λ"moment of inertia about minor axis.

$$Å = \frac{\lambda'}{\lambda''},$$

$$\lambda' = \frac{m_{20}^{c} + m_{02}^{c} - \sqrt{(m_{20}^{c} - m_{02}^{c})^2 + 4(m_{11}^{c})^2}}{2},$$

$$(2)\lambda'' = \frac{m_{20}^{c} + m_{02}^{c} + \sqrt{(m_{20}^{c} - m_{02}^{c})^2 + 4(m_{11}^{c})^2}}{2} \qquad (2)$$

Second is border irregularity. There are four value of border irregularity feature i.e. Compactness Index,Fractal Dimension, Edge Abruptnessand Pigmentation Transition. Density index (Compactness Index / CI) is the measurement of the most popular form of barrier which 2D objects estimate unanimous. However, this measure is very sensitive to noise along the boundary term amplified by the square of the perimeter

$$CI = \frac{P_L^2}{4\pi A_L}, \qquad (3)$$

PL is perimeter lesion.

To find PL value, use the surgery Robert edge detector to detect edges. Robert is a differential technique, the differential in the horizontal direction and the differential in the vertical direction, with the added conversion process after the differential binary. Binary conversion technique proposed is the conversion to level the distribution of a binary black and white. Filter kernel used in Robert's method is:

$$H = [\,-1\ 1\,] \text{ and } V = \begin{bmatrix} -1 \\ 1 \end{bmatrix} \qquad (3)$$

Fractal dimention has self-similarity characteristics, and has properties to the scale / size. Each section has a fractal is a different scale has the same nature with the whole fractal. This characteristic causes suitable for fractal compression techniques. Another characteristic is fractal dimension. Dimension size is generally an integer, such as the line has dimension 1, the field has dimension 2, and 3-dimensional cube has, and so on. However, fractal dimension is a strange as

it may worth fractions. This fractal dimension can be used as a characteristic of an image.Fractal dimension can be calculated by the method of calculation of the box (box-counting). This method divides the image into the boxes in varying sizes (r).One example of determining the value of r is 2k, with k = 0, 1, 2, ... etc, and 2k, smaller than the size of the image. Figure 3 shows illustration box-counting method.

In general, use the box grid that divides the image into a pixel size rx r. N (r) is evaluated as the number of pixels that contain pieces of barrier injury. Different pixel size and r is obtained as a slop fd regression line log (r) vs. Log (N (r)).

$$N(r) = \lambda r\text{-}fd, \quad (4)$$

Equation 4 was expanded to:

$$Log(1/N(r)) = fd \times \log(r) - \log(\lambda), \quad (5)$$

Lesion with irregular boundaries (Abruptness Edge) has a large difference in radial distance (e.g. distance d2 between the centered and the barrier GL C). Barring irregularities estimate by analyzing the distribution of radial distance difference.

$$C_r = \frac{\frac{1}{p_L}\sum p \in C(d_2(p,G_L) - m_d)^2}{m_d^2}, \quad (6)$$

m_d is the mean distance of d_2 between the centered point barrier and GL.

This important feature explains transition of skin pigmentation between the lesion and surrounding skin. Sharp edge is steep dangerous when fading slowly, do not indicate a dangerous lesion. For that, we consider component before (i, j) of the original color image as the only threecomponents are weighted the same color. Then we estimate the gradient magnitude of intensity component *lum* along the boundary before C of the skin lesion.

We obtained a set of gradient magnitude value of K, e (k) ($1 \leq k \leq K$, where K is the limiting sample size) that describes locally the transition between the injury and setting points of skin on each side. To describe more globally, we use the mean m_e and variance v_e of the gradient magnitude values e (k) which describes the level of steepness and global variations.

$$lum(i,j) = \frac{1}{3}[r(i,j) + g(i,j) + b(i,j)] \quad (7)$$

$$m_e = \frac{1}{K}\sum_{k=1}^{K} e(k), v_e = \frac{1}{K}\sum_{K=1}^{K} e^2(k) - m_e^2 \quad (8)$$

Third is color variation. One early sign of melanoma is the emergence of color variations in color. Because melanoma cells grown in grower pigment, they are often colorful around brown, dark brown, or black, depending on the production of melanin pigment at different depths in the skin. To limit further diagnosis, the color variation in a lesion described by C_h color homogeneity and the correlation between the geometry and photometry C_{pg}.

Luminance histogram of injuries are divided into three equal-length intervals. Intervals that relate to the three smallest Luminance values defined dark area in the intermediate level to relate to others from injury and is not involved in the quantification of color. Then, the color homogeneity is described as a transition zone of lighter / darker zone and the zone darker / lighter zone when the scan cuts horizontally and vertically.This attribute evaluates the distribution of color on the lesion. Including an explanation of the evolution of the color levels of the barrier centroid GL lesion. This value is larger for non-dangerous injury because it has a target aspect, whereas small values indicate danger.

$$C_{pg} = \frac{1}{A_L}.\sum_{p \in L} \frac{(lum(p) - m_l).(d_2(p,G_L) - m_d)}{v_l.v_d} \quad (9)$$

$m_d$and $v_d$are mean and variance of distance d_2, $m_l$and $v_l$are related to luminance.

Fourth is diameter. Melanoma tend to grow larger than common moles, and especially the diameter of 6mm. Because the wound is often irregular forms, to find the diameter, drawn from all the edge pixels to the pixel edges through the mid-point and averaged.

After the value of four components is found, then calculate TDV (Total Dermatoscopic Value). To get the TDV values, the formula is obtained as follows:

$$TDV = A \cdot 1.3 + B \cdot 0.1 + C \cdot 0.5 + D \cdot 0.5 \quad (10)$$

Then the value obtained has the following conclusion that are *1.00 - 4.75 - benign skin lesion, 4.75 - 5.45 - suspicious, morethan 5.45 – melanoma.*

3. Results and Analysis

In the experiment, the image that is used as input data is the dermatoscopic image suspected as melanoma. To evaluate performance system, this research uses 30 dermatoscopic images (figure 4-17).

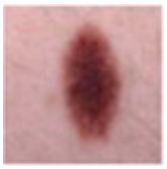


Figure 4. Uji1.jpg (219 x 250)

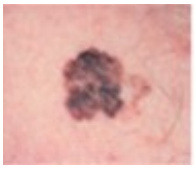


Figure 5. Uji2.jpg (504x440)

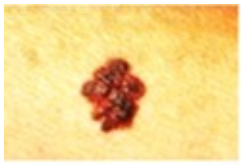


Figure 6. Uji3.jpg (691 x 648)

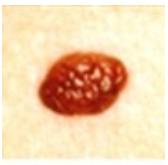


Figure7. Uji4.jpg (400 x 400)

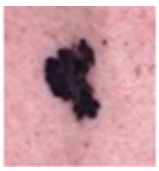


Figure 8. Uji5.jpg (227 x 250)

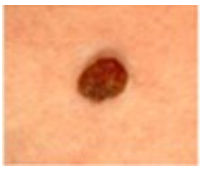


Figure 9. Uji6.jpg (300 x 388)

There are four phases that are used in this research. The first phase is preprocessing of dermatoscopicimage using median filtering. Median filtering is used for minimizing the influence of small structures like thin hairs and isolated islands of pixels like small air bubbles. The result of the first phase is shown in figure 18 and figure 19.

The second phase is segmentation of the result of median filtering. Segmentation aims to select and isolate (separate) objects from an overall image. The results of segmentation process are shown in figure 20, figure 21, figure 22, and figure 23. Figure 20 is shown the experimental result of segmentation method of dermatoscopicimage Uji1.jpg.

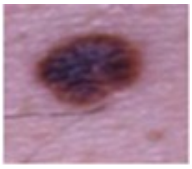


Figure 10. Uji7.jpg (228 x 203)

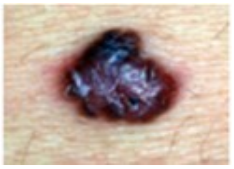


Figure 11. Uji8.jpg (437 x330)

Figure 12.Uji9.jpg (146 x 154)

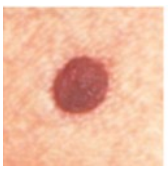


Figure 13. Uji10.jpg (400 x 259)

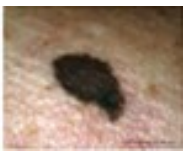


Figure 14. Uji27.jpg (600 x 481)

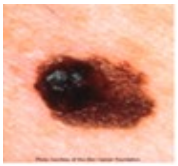


Figure 15. Uji28.jpg (400 x 400)

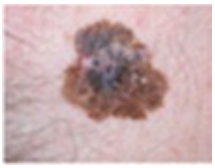


Figure 16. Uji29.jpg (320 x 240)

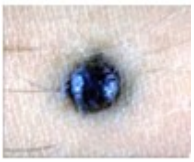
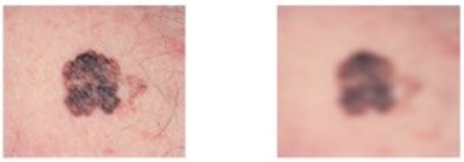


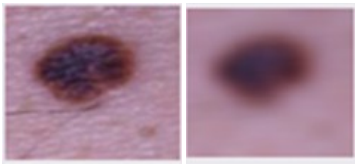
Figure 17. Uji30.jpg (185 x 139)

Figure 21 shows the experimental result of segmentation method of dermatoscopic image Uji2.jpg.Figure 22 shows the experimental result of segmentation method of dermatoscopic image Uji4.jpg.Figure 23 shows the experimental result of segmentation method of dermatoscopic image Uji5.jpg.



(a) (b)

Figure 18.Preprocessing using median filtering on image Uji.jpg: (a) Original image and (b) Filtered image.



(a) (b)

Figure 19.Preprocessing using Median Filtering on image Uji7.jpg: (a) Original image dan (b) Filtered image

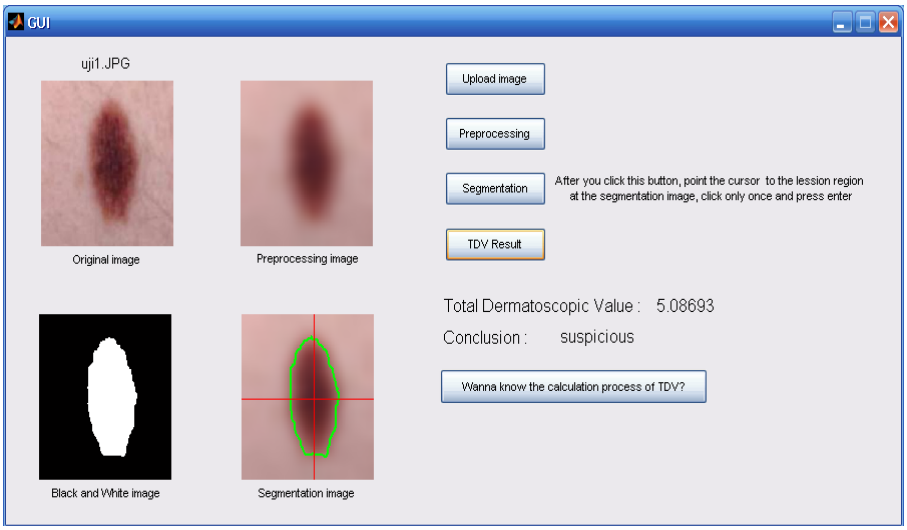


Figure 20.The result of segmentation method of image Uji1.jpg.

TABLE I
ABCD FEATURE OF IMAGE UJI1.JPG

Asymmetry	- Asymmetry Index : $7.66997*10^{-5}$
	- Lengthening Index : 0.855426
Border Irregularity	- Compactness Index : 2.13099
	- Fractal Dimension : -0.815465
	- Edge Abruptness : 0.0856846
	- Mean Pigmentation Transition : 0.0226274
	- Variance Pigmentation Transition : 0.127998
Color Variation	- Color Homogeneity : 3.72536
	- Correlation Between Photometry and Geometry : 0.00137558
Diameter	8.41715
TDV	5.08693
Conclusion	Suspicious

TABLE II
ABCD FEATURE OF IMAGE UJI2.JPG

Asymmetry	- Asymmetry Index : $3.13845*10^{-5}$
	- Lengthening Index : 0.988302
Border	- Compactness Index : 2.5006
Irregularity	- Fractal Dimension : -1.00503
	- Edge Abruptness : 0.0424384
	- Mean Pigmentation Transition : 0.0618249
	- Variance Pigmentation Transition : 1.68181
Color	- Color Homogeneity : 7.15355
Variation	- Correlation Between Photometry and Geometry : 0.000420927
Diameter	5.0138
TDV	12.5345
Conclusion	Melanoma

The third phase is ABCD feature extraction. The experimental result is the ABCD feature. The result of ABCD feature extraction of image dermatoscopic Uji1.jpg is shown in table I.

The result of ABCD feature extraction of dermatoscopic image Uji2.jpg is shown in table II. The result of ABCD feature extraction of dermatoscopic image Uji3.jpg is shown in table III. The result of ABCD feature extraction of dermatoscopic image Uji5.jpg is shown in table IV. The TDV result in table IV is 3.83346 and the conclusion of diagnosis is benign skin. Actually image Uji5.jpg is melanoma skin cancer therefore the diagnosis is false. In table IV is shown value of variation color is small caused the diagnosis result is benign skin.

The fourth phase computes Total Dermatoscopic Value (TDV) and gets the conclusion i.e. benign skin lesion, suspicious, or melanoma. Figure 11 describe the user interface of the TDV result.The experimental result of totaldermatoscopic image is described in table V. There are4 images that are falsely diagnosed of 30 images. Therefore the performance of system shows that the accuracy is 85%.

TABLE III
ABCD FEATURE OF IMAGE UJI3.JPG

Asymmetry	- Asymmetry Index : $3.63847*10^{-5}$
	- Lengthening Index : 0.982284
Border	- Compactness Index : 4.46115
Irregularity	- Fractal Dimension : -1.08298
	- Edge Abruptness : 0.287306
	- Mean Pigmentation Transition : 0.21269
	- Variance Pigmentation Transition : 21.1708
Color	- Color Homogeneity : 11.5107
Variation	- Correlation Between Photometry and Geometry : $2.97229*10^{-5}$
Diameter	5.30968
TDV	13.4686
Conclusion	Melanoma

TABLE IV
ABCD FEATURE OF IMAGE UJI5.JPG

Asymmetry	- Asymmetry Index : 0.00017057
	- Lengthening Index : 0.652154
Border	- Compactness Index : 2.57621
Irregularity	- Fractal Dimension : -0.694538
	- Edge Abruptness : 0.139309
	- Mean Pigmentation Transition : 0.0863481
	- Variance Pigmentation Transition : 1.86397
Color	- Color Homogeneity : 8.16123
Variation	- Correlation Between Photometry and Geometry : 0.000900571
Diameter	6.3211
TDV	3.83346
Conclusion	Benign skin lesion

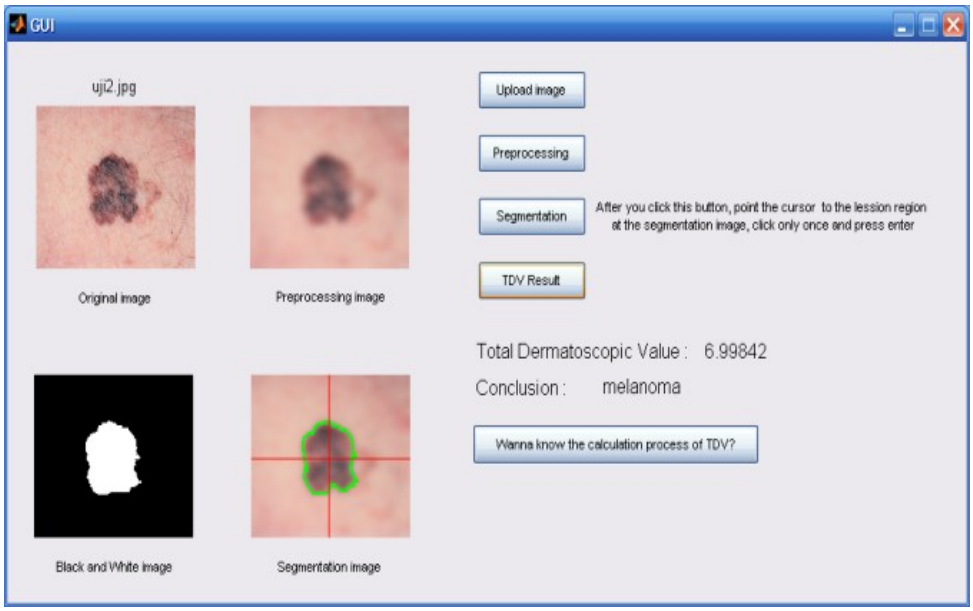


Figure 21. The result of segmentation method of image Uji2.jpg.

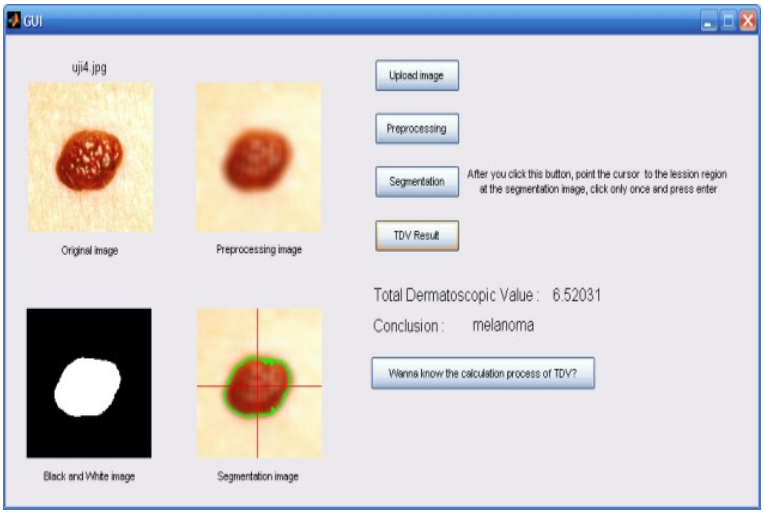


Figure22.The result of segmentation method of image Uji4.jpg.

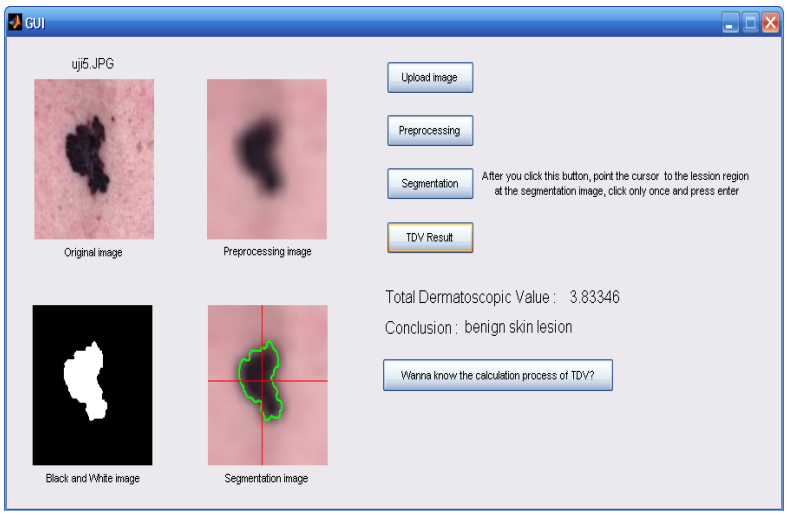


Figure 23.The result of segmentation method of image Uji5.jpg.

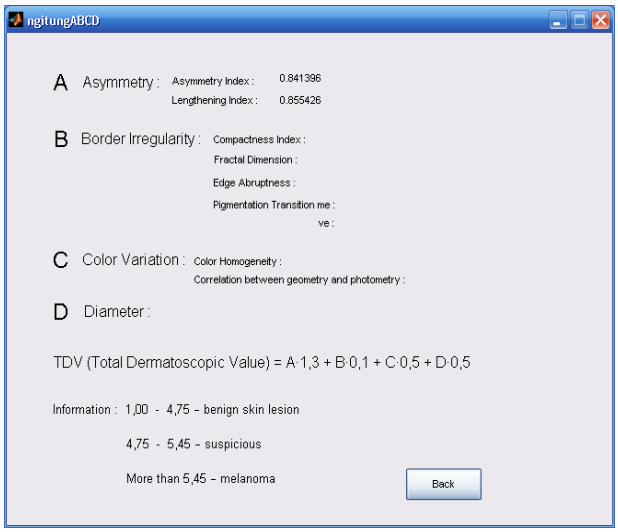


Figure 24.The TDV result user interface of the system.

TABLE V
THE EXPERIMENTAL RESULT OF 30 DERMATOSCOPIC IMAGES

Image	Score A	Score B	Sore C	Score D	TDV	Conclusion	Explanation
Uji1.jpg	0.427751	0.310368	0.582492	8.41715	5.08693	Suspicious	√
Uji2.jpg	0.494167	0.65633	0.0462289	12.5345	6.99842	Melanoma	√
Uji3.jpg	0.490375	4.87719	0.0507889	13.4686	7.8849	Melanoma	√
Uji4.jpg	0.374529	0.263462	0.0678038	11.9464	6.52031	Melanoma	√
Uji5.jpg	0.326162	0.79426	0.338945	6.3211	3.83346	Benign skin lesion	X
Uji6.jpg	0.351197	1.04477	0.0582476	7.66867	4.42449	Benign skin lesion	√
Uji7.jpg	0.364864	0.864801	0.405396	8.16409	4.84554	Suspicious	√
Uji8.jpg	0.396548	2.28933	0.119456	16.5394	9.07385	Melanoma	√
Uji9.jpg	0.450986	0.268425	0.152302	4.64363	3.01109	Benign skin lesion	√
Uji10.jpg	0.354583	0.295942	0.0132178	5.58422	3.28927	Benign skin lesion	√
Uji11.jpg	0.396252	1.44885	0.0670079	4.14274	2.76489	Benign skin lesion	√
Uji12.jpg	0.309544	1.98066	0.0173489	9.83136	5.52483	Melanoma	√
Uji13.jpg	0.328448	3.28883	0.0915796	11.7783	6.69083	Melanoma	√
Uji14.jpg	0.390142	0.70168	0.149782	19.4227	10.3641	Melanoma	√
Uji15.jpg	0.424919	1.00101	0.167049	5.086211	3.66708	Benign skin lesion	X
Uji16.jpg	0.409752	6.6472	0.135075	24.2411	13.3855	Melanoma	√
Uji17.jpg	0.429347	0.328163	0.0405218	9.91976	5.57111	Melanoma	√
Uji18.jpg	0.35925	0.316284	0.0292441	4.44386	2.73521	Benign skin lesion	X
Uji19.jpg	0.378156	1.84282	0.107087	3.42051	2.43968	Benign skin lesion	√
Uji20.jpg	0.273357	0.519681	0.124144	3.0734	2.00611	Benign skin lesion	√
Uji21.jpg	0.304099	3.0476	0.181033	6.30062	3.94092	Benign skin lesion	√
Uji22.jpg	0.369509	1.11345	0.0345816	4.74804	2.98302	Benign skin lesion	X
Uji23.jpg	0.478693	2.94293	0.22394	9.74739	5.90226	Melanoma	√
Uji24.jpg	0.292036	0.631142	0.0463403	11.3521	6.142	Melanoma	√
Uji25.jpg	0.225138	5.02343	0.0027097	20.472	11.0324	Melanoma	√
Uji26.jpg	0.391057	2.32557	0.13228	9.75279	5.68347	Melanoma	√
Uji27.jpg	0.149439	1.89094	0.0223643	14.7769	7.783	Melanoma	√
Uji28.jpg	0.286783	1.00097	0.201905	14.5841	7.86591	Melanoma	√
Uji29.jpg	0.386633	2.45403	0.124832	13.6335	7.62719	Melanoma	√
Uji30.jpg	0.363376	1.15074	0.0802555	4.20494	2.73006	Benign skin lesion	√

4. Conclusion

The experimental result shows that the ABCD feature extraction can be used to diagnose melanoma skin cancer. This research used 30 dermatoscopic images with various suspicious lesions. There are three diagnosis that is used on this research i.e. melanoma, suspicious, and benign skin lesion.The experimental result is shown that there are 4 imagesfalsely diagnosed of 30 dermatoscopic images. Therefore the performance of system showsthat the accuracy is 85%. Based on the experimental result, the small value of color variation and diameter causes false diagnosis. To improve this accuracy, it requires machine learning approach to diagnose the melanoma skin cancer.

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