To improve accuracy of localize suspicious lesion region in dermoscopic images using Region Growing, the initial step based on fuzzy sets to enhance the lesion region of interest (ROI) is developed. The result of skin lesion detection is used to extract Asymmetry, Border Irregularity, Color Variation, Diameter (ABCD) features for melanoma skin cancer diagnosis. ABCD feature is the rule that is used dermatologist for obtain the important information of image dermoscopic lesion. This feature is used to diagnose melanoma skin cancer based on Total Dermatoscopic Value (TDV). 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 dermoscopic lesion that is suspicious melanoma skin cancer. Based on the experiment, the accuracy using fuzzy region growing is 86.6% that there are 4 false diagnoses of 30 samples. But the accuracy using region growing is 76.6% that there are 7 false of 30 samples.

Keywords: skin lesion detection, malignant melanoma, fuzzy set, region growing, ABCD feature extraction.

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 experience 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 dermoscopic 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 different, 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]. In this study covered about 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 Asymmetry, Border Irregularity, Color Variation and Diameter features. Based on the research of experts got a Dermatologist that melanoma is not characteristic
asymmetrical, uneven edge of the lesion or irregular, has a different color and composition have a large diameter. Asymmetry Extraction is used to obtain information Asymmetry and lengthening Index of the object. If the Asymmetry Index value greater the chances are that the lesion is melanoma. Extraction Border Irregularity is used to obtain information Compactness Index, Fractal Dimension, Edge Abruptness, and Pigmentation Transition from the object. Extraction Border Irregularity is used to obtain information Color Homogeneity and the correlation between Photometry and Geometry of the object.

The rest of the paper is organized as follows; Section 2 describes architecture of system, preprocessing, fuzzy set and region growing method. Section 3 describes method of ABCD feature extraction. Section 4 describes about the experimental result and evaluation performance, and Section 5 describes conclusion of this research.

2. Architecture System of Melanoma Skin Cancer Diagnosis

Dermatologist 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 a variety 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.

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

All of the process of melanoma skin cancer diagnosis is described on architecture system in Figure 2.

![Figure 2. Architecture System of Melanoma Skin Cancer Diagnosis](image)

The briefly describe of each sub process on Figure 2 will be explained on next section as below.

2.1 Preprocessing

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 filter is 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. Its edge-preserving nature makes it useful in cases where edge blurring is undesirable.

The idea is to calculate the median of neighboring pixels’ values. This can be done by repeating these steps for each pixel in the image.

- Store the neighboring pixels in an array. The neighboring pixels can be chosen by any kind of shape, for example a box or a cross. The array is called the window, and it should be odd sized.
- Sort the window in numerical order
- Pick the median from the window as the pixels value
2.2 Segmentation Process

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 [3].

2.2.1 Fuzzy Set

A typical of a median filtered image consists of a very light background and a dark lesion with even darker areas inside. The enhancement of the ROI may be achieved by defining an appropriate membership function that evaluates the similarity between the properties of any current pixel and those of the ROI itself \((g_l)\). Thus, the original image \(t_l\) will be mapped to a fuzzy set according to a symmetric membership function, decreasing monotonically from 1 to 0, and assigning a membership of 1 to pixels of gray level \(g_l\). The selected function that has been defined after a study of many classical the membership functions where \(\beta\) defines the opening of the membership function. The contrasts of the ROI in the resulting image depend strongly upon the \(\beta\) value. The larger \(\beta\), the more the function is strict; the smaller \(\beta\), the more the function is permissive. The obtained fuzzy set represents pixels whose properties close the lesion with a high membership degree.

\[
m_S(p) = \frac{1}{2} \left[ \frac{2 - \beta^2 |g_l(p) - g_l|^2}{1 + \beta |g_l(p) - g_l|} \right]. \quad (1)
\]

2.2.2 Region Growing

Region growing is an approach to determine which pixels neighborhood 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 point-point 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 in the ROI and threshold 0 as a stopping condition. It starts with the seed pixel which represented the first approximation of the ROI. Four connected neighboring pixels that are above the threshold are labeled as one, these neighbors of these pixels are inspected 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.

Some things to note about the region growing:

1. The selection of suitable seed point is important.
2. The connectivity or information between pixels with neighborhood on the image will help to determine the value of threshold and seed point.
3. The determination of the minimum area threshold.
4. Similarity criteria. Some of the criteria is used, the gray level, color, and texture or shape.

How to determine the region growing:

- Specify some seed pixels. Seed can be determined manually or random.
- For each pixel seed, see 4 or 8 neighbors, if the same criteria (the criteria can be a difference gray level with the seed, etc.) then the neighbors can be considered to be in the region 1 / region with the seed pixel.
- Continue the process by checking the neighbors of current pixel.
- Stopping rule sometimes does not cover all possibilities so that at the end of the growing region have pixels that have not been checked at all.

In order to optimize the region growing results, it selects the center of a homogeneous area as the seed pixels. For this, given the set \(\zeta\) of pixels having \(g_l\) as gray level, the pixel \(S\) is selected according to the criterion defined by equation (2).

\[
|g_l - m(S)| = \min_{p \in \zeta} |g_l - m(p)|. \quad (2)
\]

Where \(m(p)\) is the mean gray level of 5x5 pixel neighborhood \(v(p)\) centered at pixel \(p\).
3. ABCD Feature Extraction

ABCD feature extraction is one of the processes to extract important features. 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.

1. Asymmetry feature
   There are two values of asymmetry feature i.e. Asymmetry Index (AI) and Lengthening Index.
   - Asymmetry Index
     Asymmetry Index value is computed with the equation (5):
     \[ AI = \frac{1}{2} \sum_{k=1}^{2} \frac{\Delta A_k}{A_L}, \]  
     where \( k \) is major and minor axis, \( \Delta A_k \) is non-overlapping area of lesion.

2. Lengthening Index
   This measurement is used to describe the elongation of a lesion, for example the degree of anisotropy of a lesion. Elongation injury is related to eigenvalue \( \lambda' \), \( \lambda'' \) from the inertia tensor matrix. This is defined by the ratio of moment of inertia \( \lambda' \) about the major axis using \( \lambda'' \) about the minor axis.
   \[
   \lambda = \frac{\lambda'}{\lambda''},
   \lambda' = \frac{m_{20} + m_{02} - \sqrt{(m_{20} - m_{02})^2 + 4(m_{11})^2}}{2},
   \lambda'' = \frac{m_{20} + m_{02} + \sqrt{(m_{20} - m_{02})^2 + 4(m_{11})^2}}{2}. \] (2)

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

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

PL is perimeter lesion.

To find PL value, surgery Robert edge detector is used 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:

\[
H = \begin{bmatrix}
-1 & 1
\end{bmatrix}
\quad V = \begin{bmatrix}
-1
1
\end{bmatrix}
\]

- Fractal Dimension
  Fractal has characteristics self-similarity, 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 2 shows illustration box-counting method.

![Figure 2. Metode Box-Counting](image-url)
the number of pixels that contain pieces of barrier injury. Different pixel size and r is obtained as a slope fd regression line log (r) vs. Log (N (r)).

\[ N(r) = \lambda r^{fd}, \]  

Equation 4 was expanded to

\[ \log(1/N(r)) = fd \times \log(r) - \log(\lambda), \]  

• **Edge Abruptness**
  Lesion with irregular boundaries (Abruptness Edge) has a large difference in radial distance (e.g. distance \(d_2\) between the centered and the barrier GL C). Barring irregularitas estimate by analyzing the distribution of radial distance difference.

\[ C_r = \frac{1}{K} \sum_{p \in C} (d_2(p, GL) - m_d)^2 / m_d^2, \]  

\(m_d\) is the mean distance of \(d_2\) between the centered point barrier and GL

• **Pigmentation Transition**
  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 three components 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 and variance \(v_e\) of the gradient magnitude values \(e(k)\) which describes the level of steepness and global variations.

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

\[ m_e = \frac{1}{K} \sum_{k=1}^{K} e(k), \quad v_e = \frac{1}{K} \sum_{k=1}^{K} e^2(k) - m_e^2. \]  

3. **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 \(C_{pg}\).

• **Color Homogeneity**
   Luminance histogram of injuries 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. Described as a transition zone of lighter / darker zone and the zone darker / lighter zone when the scan cuts horizontally and vertically.

\[ C_{pg} = \frac{1}{A_L} \sum_{p \in L} \frac{(lum(p) - m_i) \cdot (d_2(p, GL) - m_d)}{v_i \cdot v_d}, \]  

\(m_d\) and \(v_d\) are mean and variance of distance \(d_2\), \(m_i\) and \(v_i\) are related to luminance

4. **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.

2.4 Compute Total Dermatoscopic Value (TDV)
   After the value of four component is founded, then calculate TDV (Total Dermatoscopic Value). The equation of TDV as follows:

\[ TDV = A \cdot 1.3 + B \cdot 0.1 + C \cdot 0.5 + D \cdot 0.5 \]
The description of TDV as follows:
- 1,00 - 4,75 – benign skin lesion
- 4,75 - 5,45 – suspicious
- More than 5,45 – melanoma

4. Experimental Result and Analysis

In the experiment, the image that is used as input data is the dermoscopic image suspected as melanoma. To evaluate performance system, this research uses 30 dermoscopic images. There are four phases that is used in this research. The first phase is preprocessing of image dermoscopic 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 3.

Figure 3. Preprocessing using Median Filtering on Image 2
(a) Original image (b) Filtered image

The second phase is segmentation of the result of median filtering. Segmentation aims to select and isolate (separate) objects from an overall image. The comparison result between region growing method and fuzzy region growing method is shown in Figure 4 and Figure 5.

Figure 4. The result of segmentation method on Image 1 using (a) Region growing (b) Fuzzy region growing

Figure 5. The result of segmentation method on Image 2 using (a) Region growing (b) Fuzzy region growing

In figure 4, the result of fuzzy region growing method better than region growing method. The result of region growing method is more detail of boundary detection than region growing method. But in figure 5, the result of fuzzy region growing method is comparable to that region growing method.

The third phase is ABCD feature extraction. The experimental result is the ABCD feature i.e. Asymmetry feature, Border Irregularity, Color Variation and Diameter. The fourth phase computes Total Dermatocospic Value (TDV) and gets the conclusion i.e. benign skin lesion, suspicious, or melanoma. There are 4 images that are false diagnosis with fuzzy region growing and 7 images that are false with region growing method. Therefore the performance of system shows that the accuracy using fuzzy region growing is 86.6% and the accuracy using region growing is 76.6%.

5. Conclusions

The fuzzy region growing method produces better result compared to using only region growing method. This improvement is come from these factors:

1. To detect boundary lesion, the result of fuzzy region growing is more detail than region growing. Therefore the ABCD feature more accurate especially border irregularity and diameter feature.

2. To diagnosis the lesion, the component ABCD feature is very important to get the TDV. Therefore the result of diagnosis is more accurate.
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References:


