Indonesian Journal of Computer Science
ISSN 2549-7286 (*online*)
Jln. Khatib Sulaiman Dalam No. 1, Padang, Indonesia
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Skin Cancer Segmentation On Dermoscopy Images Using Fuzzy C-Means Algorithm

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Article Information

Submitted : 4 Mar 2024
Reviewed: 13 Mar 2024
Accepted : 1 Apr 2024

Keywords

Dermoscopy, Fuzzy C-Means (FCM), Skin Cancer, Segmentation

Abstract

Millions of people around the world suffer from skin cancer, a common and sometimes fatal disease. Dermoscopy has become an effective diagnostic technique for skin cancer. Precise segmentation is essential for skin cancer diagnosis. Segmentation allows more precise analysis of dermoscopic images by defining the boundaries of the lesion and separating it from surrounding healthy tissue. Dermoscopy images served as a source of research data, and Fuzzy C-Means (FCM) segmentation techniques were used. FCM is a promising method and has received a lot of attention lately. FCM is able to distinguish the various components within the lesion and effectively separate the lesion from the surrounding area. As a result, the distribution of membership degree values of each pixel in the image for each cluster represents the segmentation results obtained through FCM. The FCM technique for segmenting dermoscopic images is expected to significantly improve the precision and effectiveness of skin cancer diagnosis.

A. Introduction

Millions of people around the world suffer from skin cancer, a prevalent and sometimes fatal condition [1]. Effective treatment and better patient outcomes depend on early detection and proper diagnosis [2]. Dermoscopy has become a powerful diagnostic technique for skin cancer in recent years [3]. In-depth details regarding the composition and appearance of skin lesions are provided by dermoscopic images, which help in detecting cancer patterns. However, accurately segmenting skin cancer based on dermoscopic images is still a major difficulty [4].

When diagnosing skin cancer, accurate segmentation is very important [5]. Segmentation allows more precise analysis of dermoscopic images by defining the boundaries of the lesion and separating it from surrounding healthy tissue [6]. This allows dermatologists to recognize certain traits that signal malignant growth, such as color fluctuations, uneven borders, and asymmetrical patterns. In addition, proper segmentation makes it easy to extract quantitative information that can be used to create automated algorithms for skin cancer diagnosis [7].

Different segmentation techniques have been proposed for dermoscopic image analysis over time. These techniques can broadly be divided into two groups: model-based and threshold-based [8]. The model-based approach segments images using statistical models or machine learning techniques, while the threshold-based approach uses intensity thresholds to distinguish lesions from the background [9]. Both strategies have advantages and disadvantages, but more robust and precise segmentation techniques have recently been made possible by the development of machine learning algorithms [10].

The fuzzy c-means (FCM) method is one of the potential segmentation techniques that is in great demand these days. Unlike the conventional clustering algorithm, FCM allows soft clustering, where membership values are assigned to a specific cluster for each pixel [11]. Since skin lesions often show blurred borders and contain various structures, it is helpful in segmenting dermoscopic images [12]. FCM successfully distinguishes lesions from the background and distinguishes the various components in the lesion by considering the spatial and color information of each pixel [13].

The inequality between each pixel and the center of the cluster in question is measured with a goal function minimized by the FCM technique through an iterative optimization process [14]. The center of the cluster is initialized, and each pixel is assigned an initial membership value, when the algorithm starts. The distance of each pixel to the center of the cluster is used to update the membership value on each iteration. The final segmentation of the dermoscopic image is obtained by continuing this process until convergence [15].

A number of case studies and research publications have proven the efficacy of the FCM approach in the diagnosis of skin cancer. For example, a study by [16] examines how well different segmentation methods perform on dermoscopic image datasets. The results showed that different types of melanoma images could be successfully separated using the FCM approach. Similarly, research by [17] segmenting dermoscopic images and extracting quantitative features for skin lesion classification using FCM approach. These encouraging research findings highlight the potential of the FCM method for use in clinical settings.

According to different studies conducted by [18], the recommended algorithm is able to successfully separate skin that has lesions from healthy skin. offers a segmentation accuracy of 95.69% and comparative studies using different segmentation techniques have been conducted. Similarly, research by [19] about dermoscopic images segmented using FCM method. According to this study, the algorithm is able to accurately separate dermoscopic images, eliminate manual parameter adjustments, and interpret textures and colors. Analyzing the results of experiments can be done in several ways.

B. Research Method

We provide a thorough research methodology for skin cancer dermoscopic image segmentation in this publication. To address the shortcomings of the current approach, our method combines the advantages of an unsupervised learning-based approach and conventional image processing techniques. The recommended technique consists of several steps: segmentation using Fuzzy C-Means (FCM), image pre-processing, image input, and obtaining segmentation results. Each stage is carefully designed to overcome barriers related to skin cancer classification and improve the overall precision and robustness of the process. It will eventually be integrated into programs created with Matlab software.

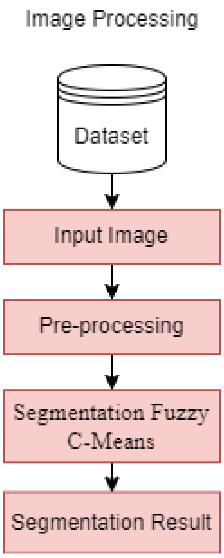

Figure1. Research Method

Figure 1 is the stages carried out in this study. Starting with dermoscopy image input, pre-processing in the form of RGB to grayscale image conversion, grayscale image segmentation using fuzzy c-means (FCM) algorithm, resulting in image segmentation.

Image Input

The first stage in this study is to input dermoscopy RGB images. This image is obtained for free from the kaggle site. Image input until the final process is done through a GUI program built using the Matlab application.

Pre-processing

The process of converting a color image into a grayscale image, where each pixel has only one intensity value that determines the brightness at that point, is called image conversion from RGB color format (Red, Green, Blue) to grayscale. Images can be processed more quickly and simply by converting to grayscale format, thus eliminating the need to take color information into account [20].

Segmentation

Fuzzy C-Means (FCM) segmentation is an image segmentation technique that divides an image into many homogeneous parts or parts using a clustering methodology [21]. Set the required number of clusters and the initial value of the cluster center first. The ownership level of each cluster is assigned to each pixel in the image. The degree of membership of a pixel indicates how close each center of the cluster is located. The probability that a pixel is part of each cluster is calculated to get this [22] .

$$u_{ij} = \left(\sum_{k=1}^{c} \left(\frac{\|x_i - v_j\|}{\|x_i - v_k\|} \right)^{\frac{2}{m-1}} \right)^{-1} \quad (1)$$

Where u_{ij} is the pixel membership degree *i* against clusters *j*. x_i is the feature vector of the pixel *i*. v_j is the center of the cluster *j*. *m* is a parameter that determines the degree of fuzzian. Getting bigger *m*, The larger the fuzzy cluster. The center of the new cluster is calculated using pixels and their membership degrees after the membership degrees of each pixel have been assigned [23].

$$v_j = \frac{\sum_{i=1}^{n} u_{ij}^{m} . x_i}{\sum_{i=1}^{n} u_{ij}^{m}} \quad (2)$$

Where v_j is the new cluster center for the cluster *j*. x_i is the feature vector of the pixel *i*. u_{ij} is the pixel membership degree *i* against clusters *j*. *m* is a fuzzian parameter. Until convergence requirements are met, such as when cluster center changes between iterations can be ignored, the process of determining membership degrees and new cluster centers will be repeated. The final segmentation of the image is obtained by classifying the pixels into clusters where each pixel has the highest degree of membership after the iteration is complete [24].

Basically, FCM calculates the membership level of each pixel (fuzzy) to all existing clusters in an attempt to group comparable pixels together. As a result, images can be segmented more precisely and can better manage pixel grouping uncertainty.

Segmentation Results

Fuzzy C-Means (FCM) segmentation results in partitioning an image into many homogeneous regions or parts, each with unique properties. Each pixel in the image is assigned a degree of membership to each cluster in the context of

FCM, which indicates how close a pixel is to each cluster center. As a result, the distribution of membership degree values for each pixel in the image for each cluster represents the segmentation result of FCM [25].

The membership degree value represents the likelihood of a pixel being part of a particular cluster. This results in a grayscale segmentation image where each pixel represents a membership degree value for a different cluster. Each pixel in this image has a membership potential in each cluster, which can be understood as a probabilistic image [26].

Therefore, users can use this information based on desired analysis or image processing requirements. The segmentation results from the FCM algorithm provide information on how close each pixel is to each cluster generated by the FCM algorithm [27].

C. Result and Discussion

The findings of this study suggest that our approach works well in identifying skin cancer through dermoscopy images. Even in the face of deviations and diversity of lesion picture, this approach can precisely describe the boundaries of skin lesions.

Pre-processing

RGB images are converted to grayscale images as part of pre-processing skin cancer images in dermoscopy imaging. Images can be processed more quickly and simply by converting to grayscale format, eliminating the need to consider color information. Figure 2 is an RGB image of the type of melanoma skin cancer. The results of conversion to grayscale are presented in Figure 3.

Figure 2. RGB Image

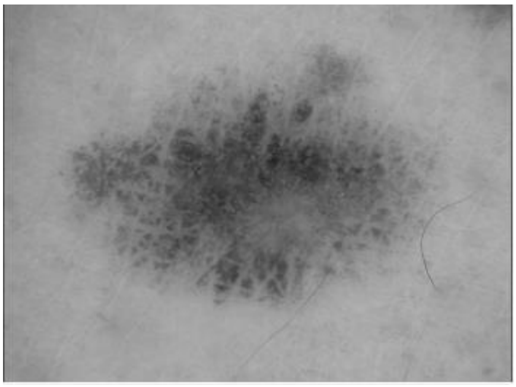

Figure 3. Grayscale Image

The results of image conversion to grayscale are carried out to clarify objects in the image and distinguish them from the background, thus facilitating the segmentation process at the next stage.

Segmentation

The segmentation stage of dermoscopy images to detect skin cancer objects was carried out using the fuzzy c-means (FCM) algorithm. The first specified cluster value is 2. The first cluster produces white objects, the second cluster produces black objects. The values of this cluster center are presented in Table 1.

Table 1. Cluster Center Value

Center 1	Center 2
97,5966930805777	159,947003743437

Central clusters generated by the FCM method are listed in Table 1. The average value of each grayscale image dimension is displayed by each cluster center that is a vector. The resulting membership degree matrix displays the proximity of each image pixel to each cluster. The two rows in this matrix correspond to each cluster, and the 1,698,020 columns correspond to each pixel in the image. A pixel is located closer to the center of the associated cluster if its value in this matrix is higher. Next is to determine image segmentation using the results of the clustering process. The segmentation results are presented in Figure 4.

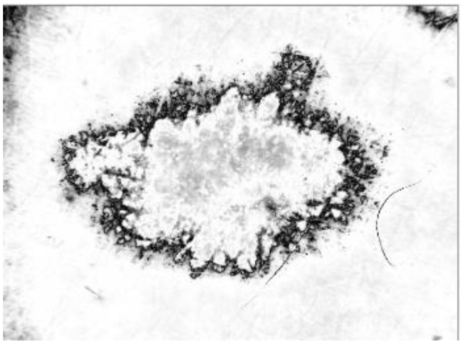

Figure 4. Segmentation Results

The resulting segmentation image is displayed in grayscale, with each pixel's greatest degree of membership to all clusters created by the FCM algorithm indicated by its pixel intensity. This provides an overview of how the image is separated into different areas or groups based on certain attributes. The clusters generated by the FCM process are then displayed. Figures 5 and 6 for Cluster 1 and Cluster 2 respectively display the results of each cluster.

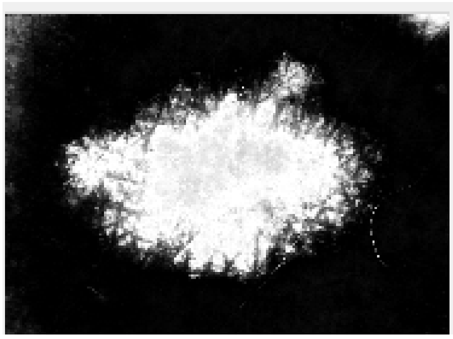

Figure 4. Cluster 1 Segmentation Results

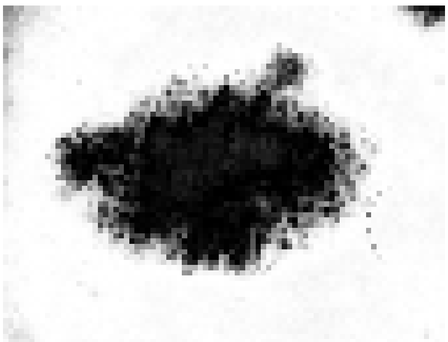

Figure 5. Cluster 2 Segmentation Results

The results of segmentation of cluster 1 and 2 images can be done well. Cluster 1 is indicated with white objects, and cluster 2 is indicated with black objects. Objects segmented using FCM have conformed to the original image of skin cancer.

D. Conclusion

For early detection and diagnosis of skin cancer, accurate segmentation of dermoscopic images is essential. For this, the fuzzy c-means (FCM) method holds promise in providing accurate depiction of skin lesions and quantitative feature extraction. Although the FCM approach has many benefits, there are some disadvantages that must be considered. Advanced research and development in machine learning algorithms is expected to overcome these barriers and open the door to the application of FCM techniques in clinical environments. Dermoscopic image segmentation has the potential to significantly improve the precision and efficacy of skin cancer diagnosis as technology evolves.

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