*Available online www.jsaer.com*

*Journal of Scientific and Engineering Research*, 2019, 6(6):65-71

**Review Article**

**ISSN: 2394-2630**
**CODEN(USA): JSERBR**

# A Review of the Skin Cancer Segmentation Methods using Digital Images

**Hamed Abd Ul Aziz**

Computer Engineering Department, Collage of Engineering, Iraq
hamedce43@gmail.com

**Abstract** A prevalent form of cancer is skin cancer. Melanoma is the most deadly type of skin cancer. Segmentation is important for image detection of skin lesion. Various techniques for segmentation of skin cancer dermoscopic pictures and other pigmented lesions are provided. Segmentation is the input image classification into healthy skin and cancerous pixels. This paper is composed of a review of different kinds of skin lesion segmentation methods is included in this paper. The primary objective of segmentation is precision, speed and effectiveness in computing.

**Keywords** Skin cancer, Image segmentation, Dermatoscope

## 1. Introduction

Skin is the outermost layer in human body which acts as a protective defense against foreign particles. Many diseases are affecting the human body such as skin cancer. In normal situation cells grow normally in which old cells are replaced by the new ones. In case of cancer, cells grow abnormally. When not diagnosed early leads to death. Most skin cancers are caused due to over exposure to Ultraviolet rays (UV) rays. Diagnosis of malicious malignancy is a difficult task. Melanoma is one such category of skin cancer that develops from the pigmented cells called melanocytes. The next type of skin cancer is Basal cell which occurs in the basal cell covering of skin. Usually found in face region due to exposure to sun. The other one is Squamous cell skin cancer found in Squamous cells, found in leg or foot. It has been proved that the death rate in Malignant Melanoma is 3 times than other skin cancer types [2].

## 2. Classification Of Segmentation

Image segmentation is the process of partitioning a digital image into multiple segments. The goal of the image segmentation is to simplify or change the representation of an image into something that is more meaningful and easier to evaluate. It is characteristically used to find objects and image boundaries (lines, curves, etc.) in images and processed of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics. It is states to the splitting of an image into separate regions that are identical with respect to luminance, color, texture etc., and techniques can be categorized in to Histogram thresholding, clustering, Edge based detection, Region based detection, morphological detection, active contours etc. Texture based segmentation algorithms have been applied to dermoscopy images. Each classification contain different methods of segmentation.

### 2.1. Edge-Based Segmentation

Edge-base or boundary-based segmentation methods [3] commonly refer to segmenting an image based on the edges among regions, by searching for edge pixels and connect them to form image contours. However for applying such methods two approaches are founded; manually, by using the mouse to draw lines that represent image boundaries among regions, and automatically, by implementing some edge detection filters, where the pixels classified into edge or non-edge according to the filter output result. Examples of some edge detection filters are: Laplacian of Gaussian filter, watershed segmentation algorithm [4].

### 2.1.1. Laplacian of Gaussian Filter

The Laplacian filter is a derivative filter applied to find the regions of rapid intensity change [5] in an image to detect the edges. Laplacian filter is a derivative filter, it is usually applied to images that have smoothed using some filters (such as a Gaussian smoothing filter) to minimize the noise sensitivity. The filters procedure normally carried out on a gray level image and produce new edged gray level image.

### 2.1..2 Watershed Segmentation Algorithm

Watershed segmentation algorithm considered as a hybrid method between edge-based and region-based segmentation. The aim of watershed segmentation algorithm is to discover the watershed lines [4] in the input image to segment the prominent regions [4]. The basic idea of the watershed algorithm can be explained as flooding water process in the topographic surface, streaming form the lowest basin to the highest peak, the water move through holes and flood the surface. To prevent merging of two different basins a dam is constructed, so that finally the boundaries of connected dam considered as the watershed edges. The main advantage of this method is the continuity of region 's boundaries, however the resultant segmented image suffer from over-segmented regions and it is time consuming as well [4].

### 2.1.3. Canny Edge Detector

Canny edge detector defined as the standard benchmark for comparing with other edge detection methods [6], canny detector algorithm consists of four steps as mentioned in: (1) uses Gaussian convolution to blur the image and reduce noise effects, (2) uses sobel operator and find the 2D spatial gradient to determine the edge directions and strength, (3) uses edge direction to search along the edges and suppress any non-edge pixels, and (4) eliminates the broken edges using two high and low thresholds [6], pixels above the high threshold are edge pixels and between the high and low thresholds which are adjacent to the edge is considered as edge pixels also. However canny edge detector can find pixels near the edge, but less in finding the exact edges [3].

### 2.2. Region-Based Segmentation

Region-based segmentation partitioned an image into regions or groups of similar pixel depending on some properties [7]. Its principle depends on the idea that neighbouring pixels within the same region have same value [4]. This idea can be implemented by comparing each pixel with its neighbours in a particular region [4], and according to the crucial similarity condition the pixel is decided to belong to a specific region [4]. In the segmentation process feature image is used instead of original input image, the feature image is represented with small neighborhoods which forms a regions [8]. Region based segmentation technique required the use of proper thresholding methods [6], and the noise has great impact on the output result [4]. Some skin classification methods based region based are: region growing, region splitting, region merging, split and merge, Neural Networks (NNs).

### 2.2.1. Region growing Techniques

In this method, uniform or homogenous regions of an image are obtained using growth techniques [9], to join the surrounding neighbourhoods together and recognize this region from other regions [9]. The idea behind the growth process begins from a preselected pixel (seed) [10], gradually agglomerates pixels that achieve homogeneity characteristic between the joined pixels, this operation stops when number of points that can be added to the region is zero[10].

### 2.2.2. Split-and-merge Techniques

This method is the inverse to region growing techniques in which it starts from nonhomogeneous image classification and continue splits the image into subdivided regions until homogeneous regions are obtained by applying some data structure algorithms [10]. The merging process joined the neighbouring regions to achieve homogeneity demands on a uniform image region.

### 2.3. Threshold Based Segmentation

Point based or pixel based segmentation, also known as thresholding. It is the simplest approach for segmenting images, depending on gray-level values to segment image pixels. For skin color classification several algorithms have been suggested, which include piecewise linear classifiers, histogram based thresholding, Neural Networks (NNs).

#### 2.3.1. Piecewise Linear Classifiers

Piecewise linear classifiers are classified as nonparametric method that divides skin and non-skin colors using a piecewise linear decision boundary. It is also known as explicit skin cluster classifier which defines clearly the boundaries of clusters in properly selected color space. Suggested a set of fixed thresholds in six color spaces YCbCr, RGB, HSV1, HSV2, HSI, and rgb, using piecewise linear classifier and use genetic algorithm to decide the boundaries of these six classifiers [11].

#### 2.3.2. Neural Network

For any artificial system application, some aspects should be considered; 1) System robustness against noise and imperfection environments, 2) Simulate the human information, 3) and real time output application system [12]. NNs tried to achieve these aims [12]. Neural networks have a huge connected processors working in parallel. Several researches have proposed the use of NNs in segmenting image. self-organizing map (SOM) and multilayer perceptron (MLP) which is feed-forward neural network (classified as nonlinear model) have been used widely in classification, compression, and regression. classified the image using self-organizing map (SOM) using HSL color space with considering only chrominance components hue and saturation, and ignoring the luminance component. Applied SOM algorithm on medical images, empirically discovered that increasing network neuron numbers will improve the performance of segmentation process [21].

## 3. Segmentation Methods

This paper includes survey of eight different skin lesion segmentation techniques from dermoscopic images. The methods are:

1. Evolutionary Strategy (ES).
2. K-means clustering.
3. Mimicking Experts Dermatologists.
4. Mean Shift automatic segmentation.
5. Joint Statistical Texture Distinctiveness.
6. Robust Snakes (RS).
7. Adaptive Thresholding (AT).
8. Fuzzy-Based Split-and-Merge Algorithm (FBSM).

### 3.1. Evolutionary Strategy (ES)

Evolutionary strategy [13] based segmentation has the property of seeking global optimum and getting out of local optimum automatically. ES is used for feature identification in natural and synthesis of images with multiple features. The lesion area is segmented by an ellipsoid, whose parameters are optimized by ES algorithm with respect to the defined objective function. Based on the inherent properties of ES algorithm, the ES based segmentation algorithm has three distinct advantages: first, it is an unsupervised segmentation algorithm whose performance does not depend on initialization or threshold values; second, robustness to artifacts and noise; third one is based on the statistical property of the image. Because of these properties, images fed into the ES based segmentation algorithm do not need to go through the above full pre-processing steps. In specific, ES based segmentation method does not need hair removal procedure. Also ES-based method does not require manually selected threshold and is robust to the initial values. The lesion area is segmented by an ellipsoid, whose parameters are optimized by ES algorithm with respect to the defined objective function. The main reason chose to use an elliptic template for segmentation is because it can be fully defined by using five parameters (population of candidate solutions, objective function, selection operator, mutation operator and a recombination operator). This makes it easy to implement an ellipsoid region based objective function. Advantages of this ES technique are ES not use threshold values, robustness to noise, and No preprocessing steps used. Disadvantages are: Low computational efficiency and less segmentation accuracy.

### 3.2. K-means clustering

K-means is a learning method for the easier implementation on set of data to classify it to a number of clusters suggested in k cluster. K-means solve the clustering problem by simply define number of centroids (k), each one will be generated using cluster. The algorithm assumes that the data features form a vector space and trying to find a compilation of the natural. According to the K-means algorithm basic assembly and groups rely on the choice of the midpoint kits. Euclidean distance used to determine the distances of the data elements suggested as K initial centers. The data elements assigned to the proper cluster according to the distance from the data elements to the centroids. The process is continued until no more changes occur in groups. This method attempts to identify similar groups of respondents based on selected characteristics. As compared to other segmentation techniques, k-means clustering requires that the analyst specifies the desired number of clusters or segments. During the procedure the distances of each respondent from the cluster centers are calculated. The procedure repeats until the distance between skin lesion cluster centers is maximized. Respondents are assigned to the cluster with the nearest center. By using k-means clustering conversion of RGB to any other color space can easily done [14]. Advantages of k means clustering techniques are: Computationally faster than hierarchical clustering, simple and easy to implement, it is versatile, and linear time and storage complexity. Demerits are: it requires number of clusters and sensitive to noise.

### 3.3. Mimicking Experts Dermatologists (MEDs)

MEDS includes mainly five stages [15]. The first stage is optional preprocessing stage, which simply preprocesses the image to rebalance its colors and to automatically remove any hair. The second stage is PCA in color space, reduces the dimensionality of the color space to one through principal component analysis (PCA) of the color histogram. The third stage is noise reduction applies a blur filter to the resulting image to reduce noise. The fourth stage is color clustering, separates pixels into two clusters through a novel thresholding algorithm which is the heart of MEDs technique and mimicks the cognitive process of dermatologists; this effectively partitions the original image into regions corresponding to lesional and nonlesional skin. The final and fifth stage is postprocessing, morphological postprocessing to remove spurious patches and to identify lesional areas in the image.

This type of segmentation is done by using 60 images of melanocytic lesions at 768 × 576 resolution were taken with a Fotofinder digital dermatoscope [19]. 12 copies of each image were printed on 13 cm × 18 cm photographic paper. A copy of each image and a special marker pen were given to each of four junior, four senior, and four expert dermatologists (having, respectively, less than one year of experience, more than one year but no specific dermatoscopic training, more than one year and specific dermatoscopic training). Each dermatologist was asked to independently draw with the marker the border of each lesion. The results were scanned and realigned to the same frame of reference, and the contours provided by the markers were then extracted and compared identifying, for each pixel of each original image, the set of dermatologists classifying it as part of the lesion or of the surrounding nonles ional skin; This "pen-and-paper" approach aimed at maximizing the comfort of dermatologists, thus minimizing the noise in border localization caused by the use of unfamiliar software drawing tools [20]. In this technique melanocytic lesion segmentation is performed by highly expert human dermatologists. Advantages are: it provide accuracy, extremely robust, and extremely fast. Drawback is availability of highly expert dermatologists.

### 3.4. Mean Shift automatic segmentation

Mean Shift segmentation technique is a non-parametric clustering technique [16]. It means it does not require the number of clusters as a priori information. This represents a major advantage because, generally, when using automatic segmentation, one can easily obtain incorrect results, since the classical segmentation techniques are often based only on assumption of guessing the number of classes existing in the image. Another important advantage of the Mean Shift method is its excellent tolerance to non-uniform background [17]. Due to intrinsic complexities of the lesions, such as blurriness, noise, the overlapping hair and other factors mentioned in the section above, and also due to a large variability in the texture and color and the non-homogeneous nature of lesions, there is a number of problems associated with the
accuracy of Mean-Shift segmentation results.

### 3.5. Joint Statistical Texture Distinctiveness

This method is a texture based segmentation algorithm. This segmentation algorithm based on texture distinctiveness (TD) to locate skin lesions in photographs. This algorithm is referred to as the TD lesion segmentation (TDLS) algorithm. The main contributions are the introduction of a joint statistical TD metric and a texture-based Region classification algorithm.TD captures the dissimilarity between learned representative texture distributions. This region classification algorithm incorporates the texture information captured by the TD metric [1]. The TDLS algorithm mainly consists of two main steps. First, a set of sparse texture distributions that represent skin and lesion textures are learned. A TD metric is calculated to measure the dissimilarity of a texture distribution from all other texture distributions. Second, the TD metric is used to classify regions in the image as part of the skin class or lesion class [1]. The grouping of lesion features are done by using k-means clustering. K-means clustering is used as an initial step to increase the robustness and to speed up the number of iterations required for the finite mixture model to converge. K-means clustering finds K clusters of texture data points that minimizes the sum of squared error between cluster members and the cluster mean. To improve clustering efficiency Expectation and Maximization algorithm is used. Then use the SRM (Statistical Region Merging) method to extract cluster features. SRM contains two main steps: a sorting step and a merging step. SRM sorts pixels in an image to determine the order in which pixels are compared, and then merges pairs of pixels into regions based on their similarity. To maximize lesion region adaptive thresholding technique is used. After the regions are classified as being normal skin or lesion, postprocessing steps are applied to refine the lesion border such as morphological dilation and region selection. First, the morphological dilation operator is applied to fill holes and smooth the border. Morphological dilation is a process that expands binary masks to fill small holes. Morphological dilation to remove non lesional area from the image. Second, since multiple noncontiguous regions may have been identified as part of the lesion class, the number of regions is reduced to one. While it is possible to have multiple lesions in a single image, it is necessary to reduce the number of lesions for the feature extraction step. To eliminate the small regions, the number of pixels in each contiguous region is counted. The contiguous region with the largest number of pixels is assumed to correspond to the lesion class and any other regions are converted to the normal skin class. This gives the final lesion segmentation. Advantages are: high accuracy, high sensitivity to noise and much faster. As compared to other techniques this method provides greater segmentation accuracy and more effective one.

### 3.6. Robust Snakes (RS)

This method is a robust active contour algorithm (EM-Snakes). The EM-Snakes tries to estimate the object contour using elastic models in the presence of cluttered background i.e., some of the features extracted from the image (e.g., edge points) should not attract the model. The EM-Snake is based on two key ideas. First, line segments are detected in the image since they are more reliable than edge points. Second, a robust estimation method is used to fit an elastic curve to relevant segments. This method assigns confidence degrees to the segments and recursively updates them during the estimation process [22].

### 3.7. Adaptive Thresholding (AT)

This algorithm is a very simple technique based on image thresholding. The color of each pixel is compared with a threshold T and classified as active (lesion) if it is darker than the threshold. The output of this step is a binary image. Morphological pos-processing is then applied to fill the holes and to select the largest connected component in the binary image. It was experimentally found that the blue RGB component is the one which allows the best discrimination of skin lesions and was adopted in this study. The threshold T is automatically updated for each image since the color of skin lesions varies. The threshold was set equal to the darkest color in the dermoscopic image plus a constant offset. Therefore

T = Tmin +T0 where Tmin is the darkest color and T0 is the offset. [22].

### 3.8. Fuzzy-Based Split-and-Merge Algorithm (FBSM)

The fuzzy-based split- and-merge algorithm (FBSM),originally aims at unsupervised perceptual segmentation of natural color images. Since the algorithm has the significant advantage to stop the process at the specified number of segmented regions, it is applicable to the segmentation of dermoscopic images. First, the FBSM algorithm extracts color features and texture features from an original image. The values of L*,a*,and b* are used as color features, and the statistical geometrical features (SGF) are used as texture features. Then, a split-and-merge technique is executed in four stages: simple splitting, local merging, global merging and boundary refinement. During the latter three stages, the similarity of any adjacent regions is estimated using the fuzzy-based homogeneity measure that combines the similarity of color features and texture features with different degrees of importance. The adoption of a fuzzy-based homogeneity measure simplifies the complex mechanism of integrating different features by means of sym bolic representations.[23]

## 4. Conclusion

Segmentation is the separation of the healthy skin and cancerous pixel input image. This article contains a review of eight distinct skin lesion segmentation methods. Everyone has distinct characteristics. The most frequently used method for classifying segmentation is a threshold based method. The main segmentation features are accuracy. Each method has benefits and disadvantages compared to eight distinct techniques each have advantages and disadvantages. In which greater segmentation accuracy is provided by Joint statistical texture distinctiveness method.

## References

[1]. Jeffrey Glaister, Alexander Wong, and David A. Clausi, “Segmentation of Skin Lesions From Digital Images Using Joint Statistical Texture Distinctiveness ”, IEEE Trans. on Biomedical Engg., vol. 61, no. 4, April 2014.

[2]. T.D. Srividya, V. Arulmozhi ,"A Review of Threshold based Segmentation for Skin Cancer with Image", International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-7, Issue-5C, February 2019

[3]. Hassana Grema Kaganami, Zou Beiji, “Region-Based Segmentation versus Edge Detection”, IEEE Fifth International Conference on Intelligent Information Hiding and Multimedia Signal Processing, pp. 1217- 1221, 2009. DOI: 10.1109/IIH-MSP.2009.13

[4]. Yu-Hsiang Wang, “Tutorial: Image Segmentation”, Graduate Institute of Communication Engineering National Taiwan University, Taipei, Taiwan. Available:http://disp.ee.ntu.edu.tw/meeting/%E6%98%B1%E7%BF%94/Segmentation%20tutorial.pdf

[5]. Rafiqul Zaman khan, Noor Adnan Ibraheem, “Survey on Gesture Recognition for Hand Image Postures”, Canadian Center of Computer and Information Science, Vol. 5(3), pp. 110-121, May 2012. doi:10.5539/cis.v5n3p110.

[6]. Hassana Grema Kaganami, Zou Beiji, “Region-Based Segmentation versus Edge Detection”, IEEE Fifth International Conference on Intelligent Information Hiding and Multimedia Signal Processing, pp. 1217- 1221, 2009. DOI: 10.1109/IIH-MSP.2009.13

[7]. http://homepages.inf.ed.ac.uk/rbf/CVonline/LOCAL_C OPIES/RAMANI1/node19.html

[8]. Krishna Kant Singh, Akansha Singh, "A Study Of Image Segmentation Algorithms For Different Types Of Images", International Journal of Computer Science Issues IJCSI, Vol. 7(5), September 2010.

[9]. Władysław Skarbek , Andreas Koschan, "Color Image Segmentation: A Survey", Berlin, Germany, October 1994. Available: http://imaging.utk.edu/~koschan/paper/coseg.pdf

[10]. L. Lucchese , S. K. Mitra, "Color Image Segmentation: A State-of-the-Art Survey", Indian national science academy, Vol. 67(2), pp.207-221, 2001. Doi: 10.1.1.84.4896

[11]. Francesca Gasparini, Raimondo Schettini, "Skin Segmentation Using Multiple Thresholding", In Internet imaging VII, IS and T/SPIE, pp. 60610F-1- 60610F-8.SPIE 2006. Available: http://www.ivl.disco.unimib.it/papers2003/EI06-EI109%20Skin-paper.pdf

[12]. Shuying Zhao, Wenjun Tan, Shiguang Wen, and Yuanyuan Liu, "An Improved Algorithm of Hand Gesture Recognition under Intricate Background", the First International Conference on Intelligent Robotics and Applications (ICIRA 2008),: Part I. Springer-Verlag Berlin Heidelberg, pp. 786–794, 2008. Doi:10.1007/978-3-540-88513-9_85

[13]. Nikhil R. Pal, Sankar K. Pal, "A Review on Image Segmentation Techniques", Elsevier Pattern Recognition Vol. 26(9), pp. 1277–1294, may 1993.doi: 10.1016/0031-3203(93)90135-J.

[14]. Ning Situ, Xiaojing Yuan, Nizar Mullani, George Zouridakis, "Automatic Segmentation of skin lesion images using Evolutionary Strategy", 2007.

[15]. Max Mignotte, "Segmentation by Fusion of Histogram-Based K-Means Clusters in Different Color Spaces", IEEE Trans. On Image Processing, vol. 17, no. 5, may 2008.

[16]. Francesco Peruch, Federica Bogo∗, Michele Bonazza, Vincenzo-Maria Cappelleri, and Enoch Peserico, "Simpler, Faster, More Accurate Melanocytic Lesion Segmentation Through MEDS", IEEE Trans. on Biomedical Engg., vol. 61, no. 2, February 2014.

[17]. Alina Sultana, Mihai Ciuc, Tiberiu Radulescu,Liu Wanyu, Diana Petrache," Preliminary work on Dermatoscopic lesion Segmentation", 20th European Signal Processing Conference (EUSIPCO 2012) Bucharest, Romania, August 27 - 31, 2012.

[18]. D. Comaniciu and P. Meer, "Mean Shift: A robust approach toward feature space analysis", IEEE Trans. Pattern Analysis and Machine Intelligence, vol. 24, no. 5, pp. 603-619, May 2002.

[19]. FotoFinder Systems Inc., "Fotofinder dermoscope," [Online]. Available:http://www.fotofinder.de/en.html

[20]. A. Belloni Fortina, E. Peserico, A. Silletti, and E. Zattra,"Where's the naevus? Inter-operator variability in the localization of melanocytic lesion border," Skin Res. Tech., vol. 18, no. 3, pp. 311–315, 2011.

[21]. Constantino Carlos Reyes-Aldasoro, Anal Aura Aldeco, "Image Segmentation and Compression Using Neural Networks", available http://www.cisst.org/~cista/446_2004/papers/SegAndCompression.pdf

[22]. T. Mendonc, A. S. Marc¸ A. Vieira, J. C. Nascimento, M. Silveira, J. S. Marques, J. Rozeira, "Comparison of Segmentation Methods for Automatic Diagnosis of Dermoscopy Images", Proceedings of the 29th Annual International Conference of the IEEE EMBS Cité Internationale, Lyon, France, pp.6572 – 6575, August 23-26, 2007.

[23]. M. Silveira, J. C. Nascimento, J. S. Marques, A. S. Marçal, T. Mendonça, S. Yamauchi, J. Maeda, and Jorge Rozeira, "Comparison of Segmentation Methods for Melanoma Diagnosis in Dermoscopy Images", IEEE Journal of Selected Topics in Signal Processing, VOL. 3, NO. 1, pp.35-45, February 2009.