# Minimum Spanning Tree Algorithm and Connected Components for Skin Cancer Image Object Detection

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**Abstract**

In the present paper, a Skin Cancer Image Object Detection method based on Minimum Spanning Tree Algorithm and Connected Components is proposed.
we propose minimum spanning tree algorithm which that capable of Segment with Extraction of connected boundaries for Skin Cancer Image Segmentation . The algorithm is proposed to create a graph using the local features minutiae points in skin cancer as objects image ,one can draw a map connect these point so the work will be able to segment any part of the skin cancer image by finding the map of the part by minimum spanning tree algorithm. The performance of the proposed detector compares favorably both computationally and qualitatively, in comparison Object Detection with Connected Components which are also based on surround influence .The last stage contains Extraction of connected components skin image edge detection . The proposed scheme can serve as a low cost preprocessing step for high level tasks such shape based recognition and image retrieval. The experimental results confirm the effectiveness of the proposed algorithm.
**Keywords**: Skin cancer image, Image Segmentation, Object Detection, minimum spanning tree, Extraction of connected boundaries ,Connected Components .

## 1- Introduction

Human skin is the turbid media with multi-layered structure Various pigments such as melanin and hemoglobin are contained in the media. The slight changes of the structure and pigment construction produce rich skin color variation. Therefore, it is necessary to analyze the skin color based on the structure and pigment construction in reproducing and diagnosing the various skin colors. Skin detection in images is a theme that is presented in many applications. This is the first step for image recognition, for example. Other application is for naked detection, in the internet[1].

The purpose of detecting sharp changes in image brightness is to capture important events and changes in properties of the world [2]. Object detection is one of the great challenges of computer vision, having received continuous attention since the birth of the field. The most common modern approaches scan the image for candidate objects and score each one[ 3]. This is typified by the sliding-window object detection approach ,but it is also true of most other detection schemes (such as centroid-based methods or boundary edge methods. The most successful approaches combine cues from inside the object boundary (local features) with cues from outside the object (contextual cues. Recent works are adopting a more holistic approach by combining the output of multiple vision tasks and are reminiscent of some of the earliest work in computer vision [4].

Once the pixels of interest are located, unsupervised segmentation is used to separate these pixels into smaller regions which are homogeneous in color. This is a very important step because the skin detection will produce non-homogeneous regions . often containing more than one object[5]. Finally, a region merging step is introduced since the unsupervised segmentation can split the face regions into smaller homogeneous regions which has been greatly improved with respect to the work presented in [2].

The rest of the paper is organized as follows: Section 2 gives a brief outline of the Minimum spanning tree (MST), Section 3 describes the process of Connected Components, Section 4 describes the process of building the System Design and summarizes the steps of our algorithms, Section 5 shows the experimental results obtained using our method. Section 6 gives concluding remarks.

## 2. Minimum spanning tree (MST)

The minimum spanning tree problem is one of the most famous combinatorial problems in computer science. Fast algorithms to solve the problem are well-known[2]. A minimum spanning tree (MST) of a graph G = (V,E) is a minimum total weight subset of E that forms a spanning tree of G. The MST problem has been intensively studied in the past since it is a fundamental network design problem with many applications and because it allows for elegant and multifaceted polynomial-time algorithms. In practice (on sequential machines and in internal memory), two simple algorithms dating back at least half a century still perform best in most cases[6].

Clustering by minimal spanning tree can be viewed as a hierarchical clustering algorithm which follows a division approach. Using this method firstly MST is constructed for a given input. There are different methods to produce group of clusters. If the number of clusters k is given in advance, the simplest way to obtain k clusters is to sort the edges of minimum spanning tree in descending order of their weights and remove edges with first k-1 heaviest weights [7]. The characteristics of affinity matrix and then define an optimization measure based on the weighted graph associated with an image. The solution to the optimization problem satisfies the clustering standard with maximal within-class similarity and minimum between-class similarity[8].

For random graphs with random edge weights, the MST edges are expected to be among the O(n log n) lightest edges. Note that this can even happen for random edge weights: Consider a “lollipop graph” consisting of a random graph and an additional path of length k attached to one of its nodes. The MST needs all the path edges, about half of which will belong to the heavier half of the edges for random edge weights[7].

## 3. Connected Components

Segmentation is subdividing an image into its constituent regions or objects. The level up to which the subdivision is carried out depends on the problem being solved. A human skin color model is used to decide either a pixel is skin color or non skin-color[9].

Image editing tasks normally involve one or more extended contours, not single edge elements in isolation. For this reason, contour-based image editing depends upon an efficient method for specifying a group of edges to which an action is to be applied.

An efficient method for grouping edges into closed contours has recently been reported . The algorithm consists of three
main stages:

1. Line segment approximation.
2. Computation of posterior line grouping probabilities.
3. Shortest path computation of maximum-likelihood line segment cycles[10].

The next step is to remove small objects and connected the connected components for skin image that have fewer than P pixels, producing another binary image .The default connectivity is 8 for two dimensions. We used the statement BW2 = bwareaopen(BW, P, conn) to specifies the desired connectivity . Where the variable **conn** can have Value for Two-dimensional connectivity:

A) 4 if 4-connected neighborhood
B) 8 if 8-connected neighborhood

The 1-valued elements define neighborhood locations relative to the central element of **conn**. Note that **conn** must be symmetric about its central element. The basic steps for the desired connectivity are:

1- Determine the connected components:
   CC = bwconncomp(BW, conn);
2- Compute the area of each component:
   S = regionprops(CC, 'Area');
3- Remove small objects:
   L = labelmatrix(CC);
   BW2 = ismember(L, find([S.Area] >= P));

In the next step we find connected components in binary Skin image .The basic steps in finding the connected components are:

1- Search for the next unlabeled pixel, p.
2- Use a flood-fill algorithm to label all the pixels in the connected component containing p.
3- Repeat steps 1 and 2 until all the pixels are labeled

The four structure field for components are :

1-Connectivity: Connectivity of the connected components (objects)
2-ImageSize: Size of image
3-NumObjects: Number of connected components (objects) in image
4-PixelIdxList: 1-by-NumObjects cell array where the kth element in the cell array is a vector containing the linear indices of the pixels in the kth object.

## 4.System Design

The object of detection problem can be seen as a classification problem, where we need to distinguish between the object of interest and any other object. In this paper, we used Minimum spanning tree (MST) to find edge detection of object, detecting pedestrians in images [11]. Skin cancer is a disease in which cancer (malignant) cells are found in the outer layers of the skin. The skin protects the body against heat, light, infection, and injury. The skin has two main layers and several kinds of cells. The top layer of skin is called the epidermis. It contains three kinds of cells: flat, scaly cells on the surface called squamous cells; round cells called basal cells; and cells called melanocytes, which give the skin its color[9. The low level feature is the ridge characteristic called minutiae. These are the points of ridge ending(terminations) or branching[7].

In the implementation, there are 3 main process, which are the calculation of the distances between neighboring pixels, finding the Minimal Spanning Tree route, and the deciding the output type (plain, edge, corner, or junction). Those three processes are done in a sliding window where size is already defined, which is 3x3. For that reason, the original input image matrix must be added with one pixel width of pixel on each side, so that the output of the pixels at the edge of the original image can be calculated.

The steps for Algorithm work are:

1- Start

2- Input skin cancer images

3-Find features minutiae points for skin cancer images contains(point number, minutiae coordinates(x,y), Point direction).

4- Comparison between the images by find relationship between extracted points.

5- Draw lines of network

6- Canceled intersecting lines to generate the graph connecting points are extracted triangles

7- Create (Draw)new graph with information contains(Triangle number, Vertex 1, Vertex2, Vertex3).

8- Convert graph to tree by link the triangles

9- Find Minimum Spanning Tree (MST) by using Prim's algorithm .

10- Extraction of connected boundaries to segment the Skin Cancer Image.

11- Move on to the region growing calculations after edge detection for all image pixels and divided into two sets;

a. Edge Pixel Set (EPS)

b. Region Pixel Set (RPS)..

12-Cut the image into a set of regions. Pick a pixel from the RPS randomly as a seed for a new region(Ri).

13-During region growing of (Ri), all pixels in this region are moved out from the RPS and are assigned to this newborn region.

14- If the RPS is not empty, the algorithm simply picks a pixel randomly as a seed for another new region.

15-This process continues until all pixels in the RPS are placed in a set of regions.

16- Find Boundaries Object Detection for Skin Cancer Image

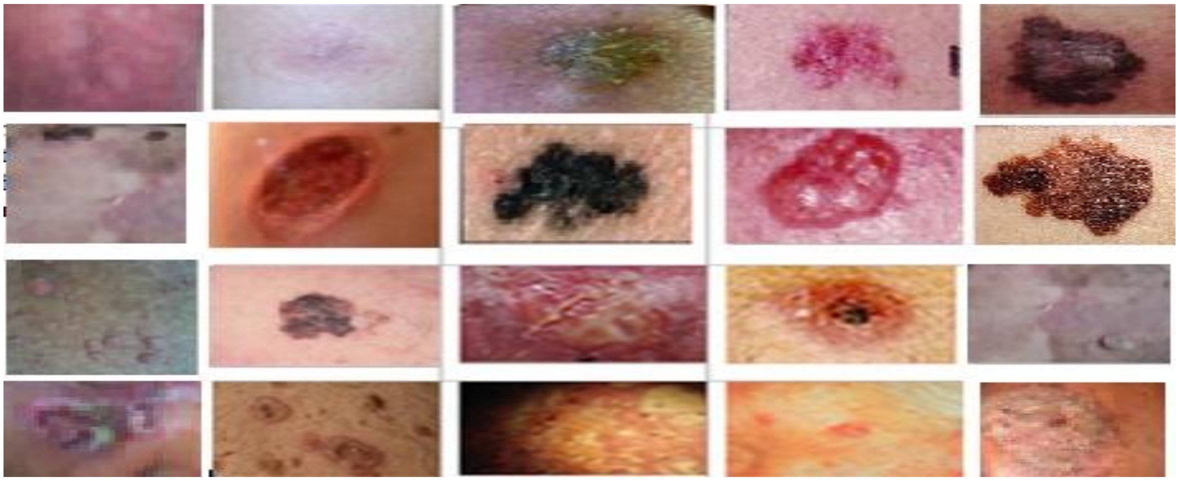
17-End

## 5.Experimental Results

In this section a detailed experimental comparison of the above stated propose minimum spanning tree algorithm is capable of Segment with Extraction of connected boundaries for Skin Cancer Image Segmentation has been presented. We have used two types Mycosis Fungoides Skin image databases:

(1) database prepared in our conditions ,images obtained from in Al-Seder Hospital.

(2) Skin database [12] and some other images obtained from internet.



Figure(1): The skin cancer images library for samples of diseases

The proposed system was applied on 100 images of skin cancer and to find out details of the final results we will take the two images here, one containing the details of the objects and the limits of a few is the image of 1 and the other containing the details of the many is the image of
Figure shows us the image of 1 and 2.

Image 1 Image 2

The minutiae are extacted by scanning the local neighborhoods of each ridge pixel in the image using a 3*3 window. The Crossing Number (CN) value is then computed ,which is defined as half the sum of the differences between pairs of adjacent pixels in the eight neighborhoods.

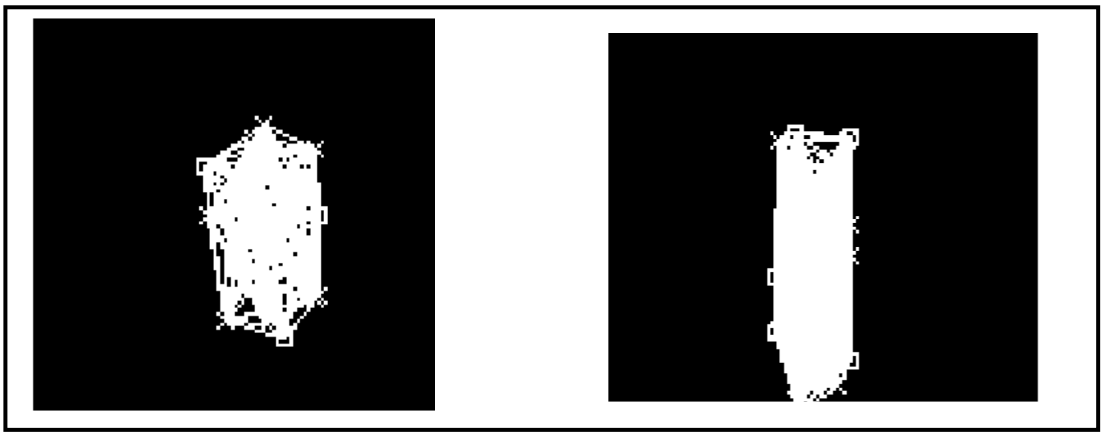
Properties of the Crossing Number(CN) are CN=0 if Isolated point , CN=1 if Ridge End point, CN=2 if Continuing point, CN=3 if Bifurcation point and CN=4 if Crossing point.

Extracted features from thinned image(called minutiae)are used for matching between the original skin image stored in the data base. The algorithm used here depend on Crossing Number(CN) concept. Step3 in algorithm above find number minutiae and minutiae Matrix contain (minutiae no., minutiae coordinates(x,y) begin by 20, minutiae type(end, bifurcation)and minutiae theta) used variables CN:crossing number ,x:raw coordinate ,y:column coordinate, minutiae counter :no. of minutiae found.

Algorithm for Minutiae Extraction
Step1: Start
Step2:Initialize minutiae counter to zero
Step3:For x=20 to (number of row )

For y=20 to (number of column)
Find CN for image(i,j)
If CN=1 or CN =3
Find Theta for image(x,y) with CN found
End if
Minutiae counter = minutiae counter +1
Store minutiae found and its information in minutiae Matrix
End for y
End for x
Step4:End

The result of finding all connections for feature points shown below



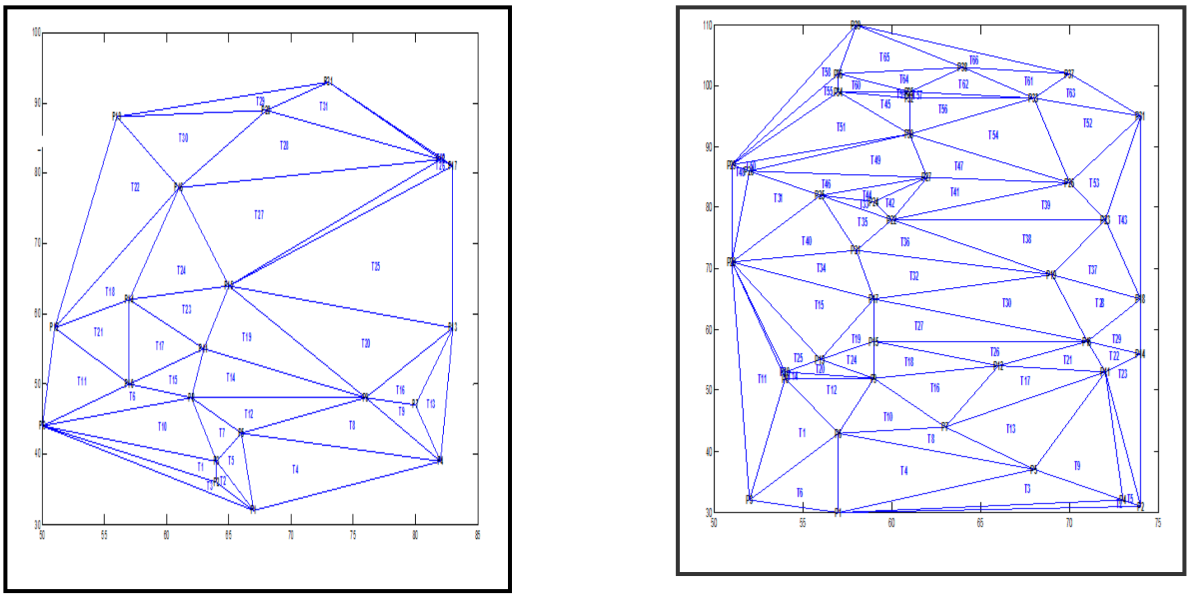
(a) (b)

Figure(2): Connect minutia points( all connection for feature points)

(a)Line Connect for imge1 (b) Line Connect for imge2

The proposed algorithm for deleting intersected lines is shown below:
Algorithm name: Remove intersected lines
Step1: Start
Step2: For i= 1 to number of lines
Take linei if it not deleted
For j= 1 to number of lines
Take line j if not deleted
Enter line i and line j to algorithm of intersect for test them
If the line i and line j intersect delete the longest one
Or delete both if they have same length
End for j
End for i
Step3:End
Algorithm draw lines connect minutiae points
Step1:Start

Step2: For i=1 to number of lines
Take first point of line(x1,y1) from line Matrix
Take second point of line(x2,y2) from line Matrix
Apply Bresenham algorithm to draw line which its points are (x1,y1) and (x2,y2)
End for i
Step3:End



**(a)** **(b)**

Figure(3): Delete intersected lines (a) for image 1 (b) for image 2

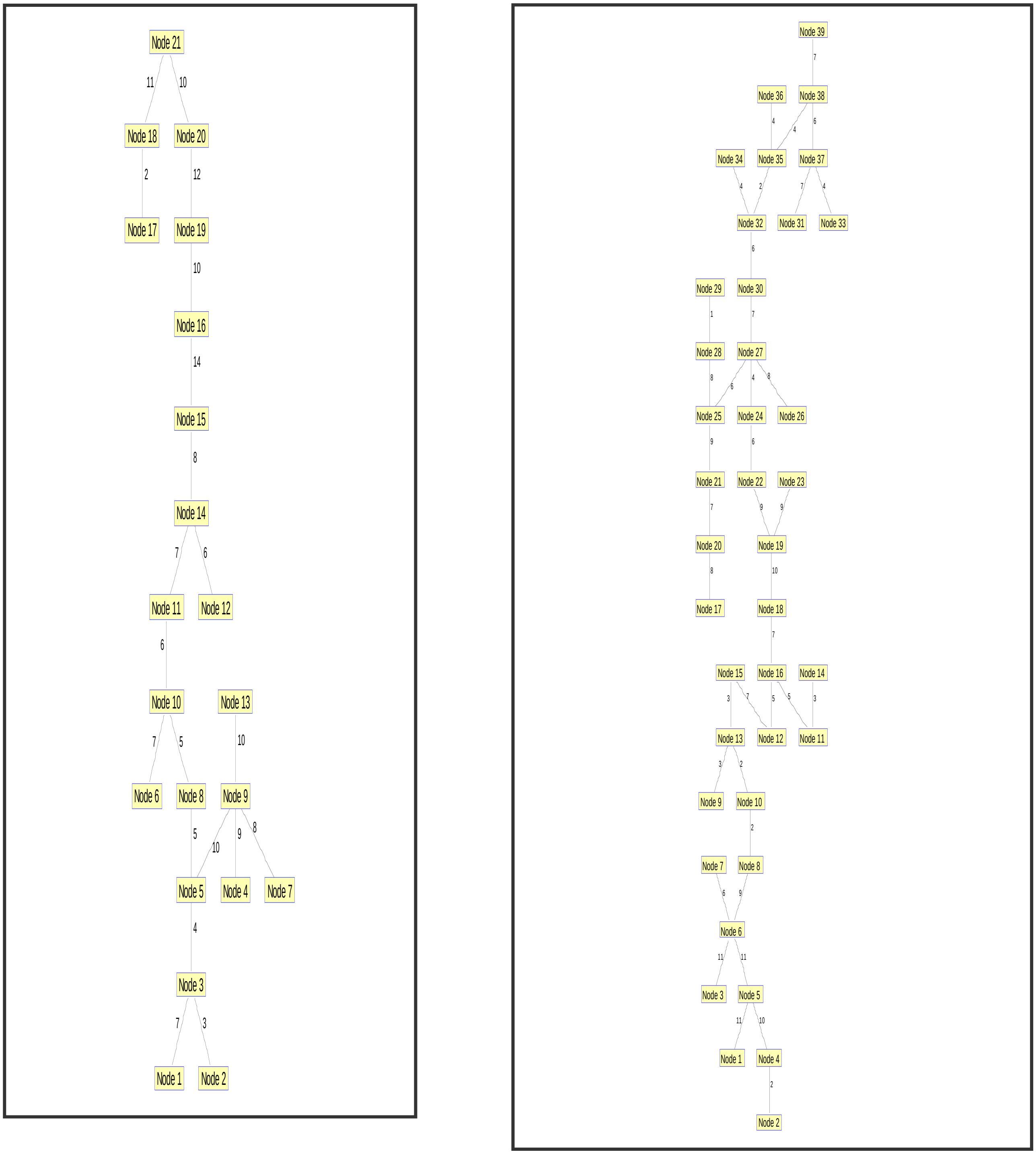
For Extraction of connected components let **A** represent for all Extraction point and **Y** represent a connected component contained in a set **A** and assume that a point p of **Y** is known. Then the following iterative expression yields all the elements of Y

$$X_k = (X_{k-1} \oplus B) \cap A \quad k= 1, 2, 3,\ldots\ldots,n \qquad (1)$$

where $X_0$ = p, and B is a suitable structuring element.

If $X_k = X_{k-1}$, the algorithm has converged and we let $Y = X_k$. This algorithm is applicable to any finite number of sets of connected components contained in A, assuming that a point is known in each connected component.

Morphological opening is performed to remove small to medium objects that are safely below the size of a Skin. A disk shaped structuring element of radius 5 is used. Morphological Dilating is in general, causes objects to dilate or grow in size; erosion causes objects to shrink[7].




(a) (b)

Figure(4): Minimum Spanning Tree (a) for image 1 (b) for image 2

The Cost value of the path for image 1 is (154) and Cost value of path for image 2 is (233)

Table(1): weights MST for image1(a) for image 1 (b) for image2 for trees in figure(4)

(a)

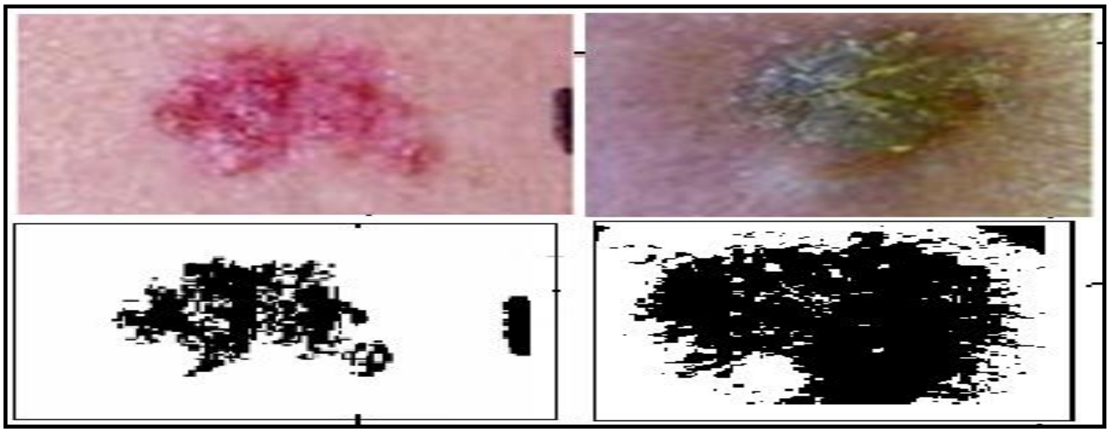
| Node | Weight |
|---|---|
| (3,1) | 7 |
| (3,2) | 3 |
| (5,3) | 4 |
| (9,4) | 9 |
| (8,5) | 5 |
| (9,5) | 10 |
| (10,6) | 7 |
| (9,7) | 8 |
| (10,8) | 5 |
| (13,9) | 10 |
| (11,10) | 6 |
| (14,11) | 7 |
| (14,12) | 6 |
| (15,14) | 8 |
| (16,15) | 14 |
| (19,16) | 10 |
| (18,17) | 2 |
| (21,18) | 11 |
| (20,19) | 12 |
| (21,20) | 10 |
| (3,1) | 7 |

(b)

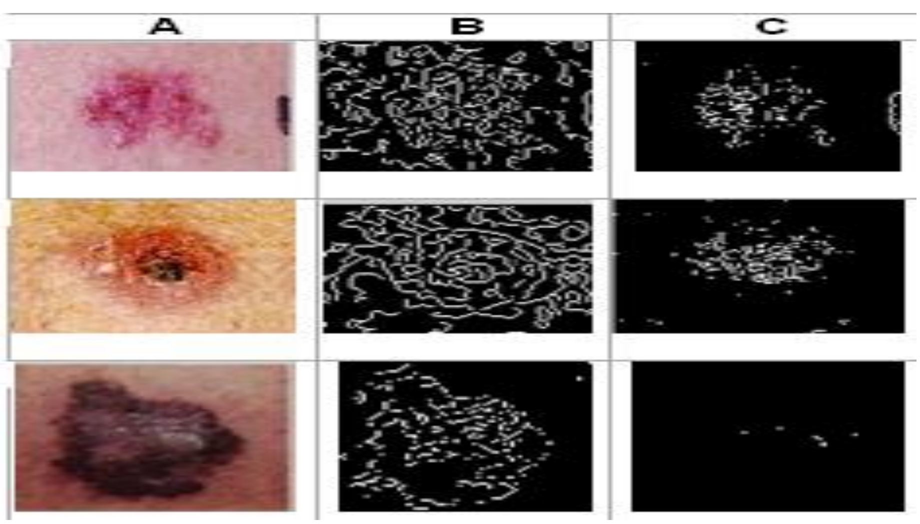
| Node | Weight |
|---|---|
| (5,1) | 11 |
| (4,2) | 2 |
| (6,3) | 11 |
| (5,4) | 10 |
| (6,5) | 11 |
| (7,6) | 6 |
| (8,6) | 9 |
| (10,8) | 2 |
| (13,9) | 3 |
| (13,10) | 2 |
| (14,11) | 3 |
| (16,11) | 5 |
| (15,12) | 7 |
| (16,12) | 5 |
| (15,13) | 3 |
| (18,16) | 7 |
| (20,17) | 8 |
| (19,18) | 10 |
| (22,19) | 9 |
| (23,19) | 9 |
| (21,20) | 7 |
| (25,21) | 9 |
| (24,22) | 6 |
| (27,24) | 4 |
| (27,25) | 6 |
| (28,25) | 8 |
| (27,26) | 8 |
| (30,27) | 7 |
| (29,28) | 1 |
| (32,30) | 6 |
| (37,31) | 7 |
| (34,32) | 4 |
| (35,32) | 2 |
| (37,33) | 4 |
| (36,35) | 4 |
| (38,35) | 4 |
| (38,37) | 6 |
| (39,38) | 7 |

The growth of the regions must satisfy certain criteria. If the criteria cannot be satisfied, the growth in the given direction will be stopped. A pixel is available only when it is contained in The Region Pixel Set (RPS). This means the pixel is not an edge pixel and has not been assigned to some other region yet. If any of these pixels is available and satisfies the criteria, the pixel is qualified to be a member of R. After addition of a pixel into Region(R), it will be a new boundary pixel of the region. The inner pixels and boundary pixels of the region are also required to update[10].

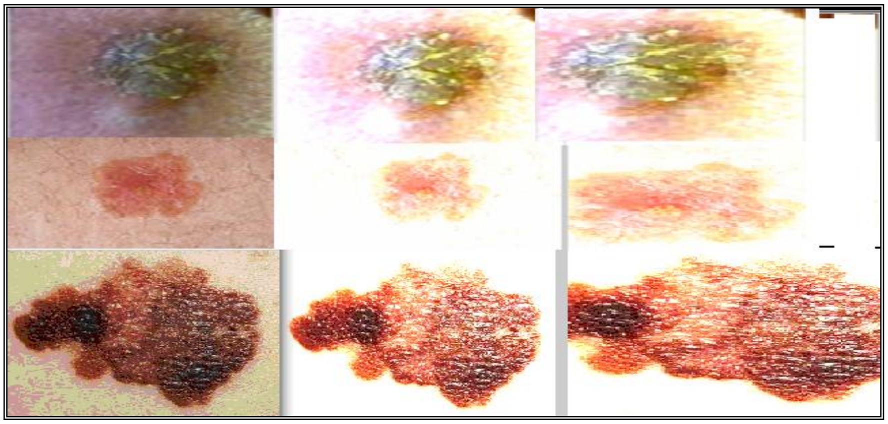
Figure (5) shown original Skin images(a),(b) and them connected components



Figure(5): original Skin images(a),(b) and connected components




Figure(6):(A):Original Skin Image ,(B)Edge for all region ,(C) Edge for Center Skin Image



Figure(7):(A):Original Skin Image ,(B)objects for all region ,(C) resize objects for all region

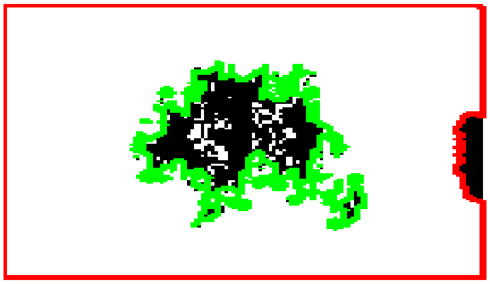
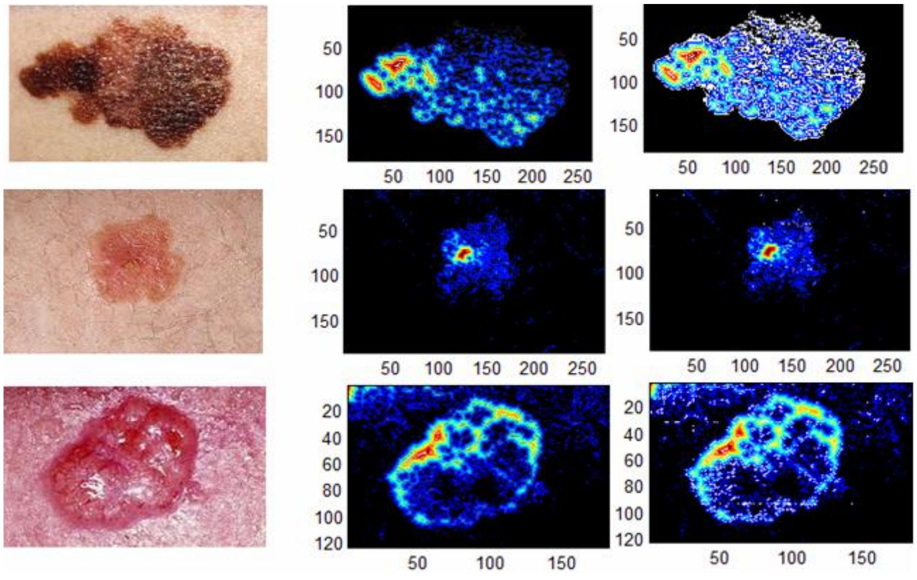


Figure (8): Region growing( Green : Boundary pixels of the Region (R), Black and white inside R: Pixels in the growing region R and White outside : Outer neighbor pixels of the region R)

Then find boundaries for Object Detection for Skin Cancer Image in figure (8).




Figure(9): Boundaries Object Detection for Skin Cancer Image

## 6. Conclusion

We propose new method using the proposed Minimum Spanning Tree algorithm which is capable of Segment with Extraction of connected boundaries for Skin Cancer Image Segmentation . We have proposed an automatic scalable object boundary detection algorithm based on edge detection, and region growing techniques. We have also proposed an efficient merging algorithm to join adjacent regions using adjacency graph to avoid over segmentation of regions.By identifying objects in images, we have shown that our approach works well when objects in images have less complex organization. Experiment results have demonstrated that the proposed scheme for boundaries works satisfactorily for different levels digital images. Another benefit comes from easy implementation of this method. This method is necessary to provide a robust solution that is adaptable to the varying noise levels of these images to help in distinguishing valid image contents from visual artifacts introduced by noise. The experimental results show the satisfying subjective test results and the simulation results are very promising.

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