ISSN (Print) : 0974-6846
Indian Journal of Science and Technology, *Vol 8(22), DOI: 10.17485/ijst/2015/v8i22/79140, September 2015* ISSN (Online) : 0974-5645

Normalised Otsu's Segmentation Algorithm for Melanoma Diagnosis

J. Premaladha[1*], M. Lakshmi Priya[2], S. Sujitha[2] and K. S. Ravichandran[1]

[1]School of Computing, SASTRA University, Thanjavur - 613401, Tamil Nadu, India; premaladha@sastra.edu
[2]Department of ICT, School of Computing, SASTRA University, Thanjavur - 613401, Tamil Nadu, India

Abstract

Melanoma is a deadly skin cancer which increases the death rate at a faster rate. In order to bring the death rate under control, melanoma should be detected at its earlier stage. To achieve this, researchers have introduced Computer aided diagnosis and adopted the same. In this technique, Segmentation is found to be one of the important steps. Many algorithms exist in practise for segmentation,where one of the important algorithms is Traditional Otsu Segmentation Algorithm. In this algorithm the major drawback is that the segmentation is improper in the presence of variable illumination. This paper proposes an algorithm "Normalised Otsu Segmentation" which overcomes the above mentioned drawback and results in an accurate segmentation. This algorithm first normalises the image to overcome variable illumination and then segments the image using Otsu algorithm. The accurate result given by this algorithm can be used in further steps to detect the lesion accurately which will provide a hand a for reducing the death rate.

Keywords: Illumination, Melanoma, Normalisation, Otsu's Algorithm, Segmentation

1. Introduction

Melanomacan be detected at earlier stage using computer aided analysis in which segmentation is the major and important step[1-3]. Segmentation is done with the help of Segmentation algorithm to speed up the process. After segmenting the image into subregions measurements on each region can be accomplished[4]. Therefore segmentation is a major step for significant analysis of image data. Various techniques have been proposed for segmentation in many literatures. Discontinuity and similarity are the two properties based on which categorization of image segmentation method is done[5]. Region based and edge based segmentation are the two categories of image segmentation based on these properties. Based on the property of discontinuity of pixels segmentation methods are classified as edge or boundary based techniques. A binary image is the result of edge based segmentation. The two categories of edge based segmentation methods are gradient based and gray histogram based methods[6]. Various types of region based segmentation methods are merging, region growing, thresholding and region splitting[6]. The skin images are segmented with the help of textures and image grey values separately[7]. Then the results were combined to obtain the boundaries of the lesion. The differences in Texture and colour between the surrounding skin and lesion were used as a key factor to segment the image in the technique used by[8]. Thresholding is the easiest and simple technique in Segmentation. Otsu's method is the most widely used one in thresholding. Otsu's method is used widely because of its simplicity and effectiveness[9]. Otsu's algorithm produces a satisfactory result even when applied on noisy images. Even though Otsu's method works well on real time images, it fails to produce an accurate result in the presence of variable illumination[10]. Hence to overcome the problem of variable illumination and to yield accurate results on all type of images the proposed algorithm can be implemented. The major drawback of Otsu's algorithm can be overcome by this "Normalised Otsu's Segmentation Algorithm".

*Author for correspondence

The organization of the paper follows the pattern as described below. Section 2 contains the proposed algorithm which describes about the Normalized Otsu's Segmentation algorithm. Section 3 contains the implementation of the algorithm on melanoma images. Section 4 gives the comparison of proposed algorithm with existing Otsu algorithm. Section 5 gives the result and the conclusion is described in Section 6.

2 Proposed Algorithm

Images with variable illumination cannot be segmented properly with Otsu's method. In order to segment an image with Otsu's method with more accuracy,the variable illumination problem should be overcome. This paper proposes an algorithm which overcomes the illumination problem and produces a more accurate result by indulging Otsu's method in it. "Normalised Otsu's Segmentation Algorithm" is the proposed one which first normalises the image before applying Traditional Otsu's algorithm. When an image is normalised its intensity becomes uniform. When this normalised image is segmented by applying Otsu's method the result is more accurate and clear. Local-Global block analysis[11] is used for normalising the image. The technique is based on macro and micro level analysis. Local information is provided by local blocks. The information about the entire image is produced by global blocks. In Melanoma images the affected lesion is the local block. The entire image size of considered melanoma image is assumed as P X Q. The lesion portion is considered as local block and its size is considered as A X B. First the local block's local mean is calculated using the formula.

$$\lambda_{local} = \sum_{x=1}\sum_{y=1} f(x,y)/A\ x\ B \quad (1)$$

After calculating local mean, the global mean is calculated for the entire melanoma image using the formula.

$$\lambda_{global} = \sum_{x=1}\sum_{y=1} f(x,y)/P\ x\ Q \quad (2)$$

The local mean and the local pixel's difference are obtained from the formula.

$$\text{Change} = f(x,y) - \lambda_{local} \quad (3)$$

Finally the new normalised image is obtained by

$$\text{Change} = f(x,y) - \lambda_{local} \quad (4)$$

The addition process is used in normalisation. This normalised image is applied to Otsu's algorithm. Threshold is found using Otsu's algorithm[12,13]. The found threshold is scaled. If the pixel value is greater than the threshold value, it is set to 1 else the pixel value is set to 0.

```
Procedure: Normalized Otsu's Segmentation
Input: Pre-processed image I
initialiselocalmean := 0; globalmean := 0; sum:=0; sum1:=0; A; B; P; Q;
// finding mean for the entire image (Global mean)
        begin
        for i=1 to 256
                begin
                for j=1 to 256
                        sum:=sum+I[i,j];
                increment j by 1
                end
        increment i by 1
        end
        globalmean:=sum/A X B;

// finding mean for the target block (local mean)
        begin
        for i=4 to 110
                begin
                for j=232 to 134
                        sum1:=sum1+I[i,j];
                decrement j by 1
                end
        increment i by 1
        end
        localmean:=sum1/P X Q;

//finding the difference between the image and the local mean values
        change := I-localmean;
//Find the normalized image
        Newimage:=change+globalmean;
//Find threshold using Otsu's method & Scale the threshold value
//Segmenting the image based on the threshold value obtained
    begin
    for i=1 to 256
                begin
                for j=1 to 256
                        If Newimage(i,j)>threshold
                                Newimage(i,j):=1;
                        else
                                Newimage(i,j):=0;
                        increment j by 1
                end
        increment i by 1
        end
//display the segmented image
        disp(Newimage);
```

3. Implementation

Figure 1 illustrates the pre processed image. Figure 2 illustrates the image which is segmented using Traditional Otsu's Segmentation algorithm. It is observed that the segmented image does not provide much clear information due to the presence of variable illumination. To make the intensity uniform and get a clear segmented image normalisation of image is done. Normalised image is shown in Figure 3. When normalised image is segmented using Otsu's algorithm, a clear image is obtained. Figure 4 show the image segmented using Normalised Otsu's Segmentation algorithm. This image is segmented with more accuracy.

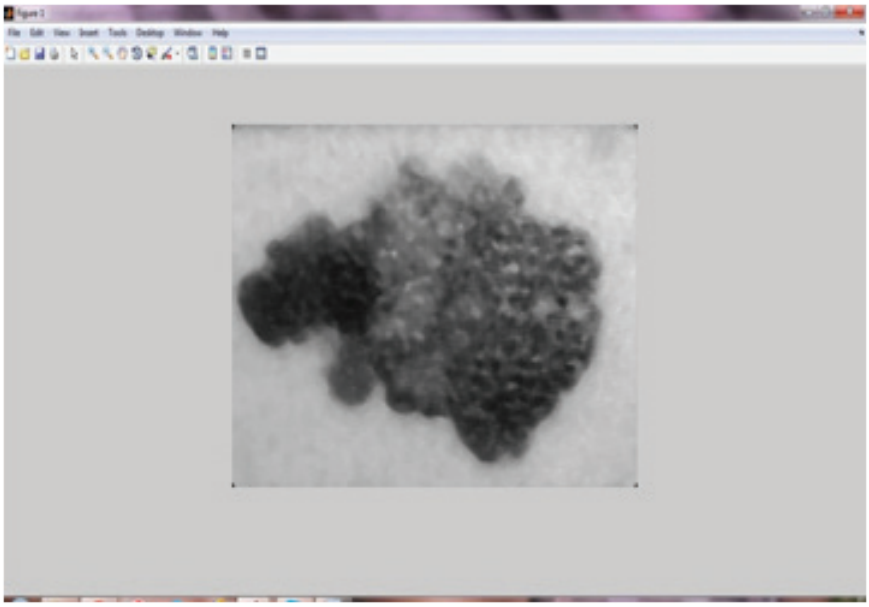

Figure 1. Pre-processed image.

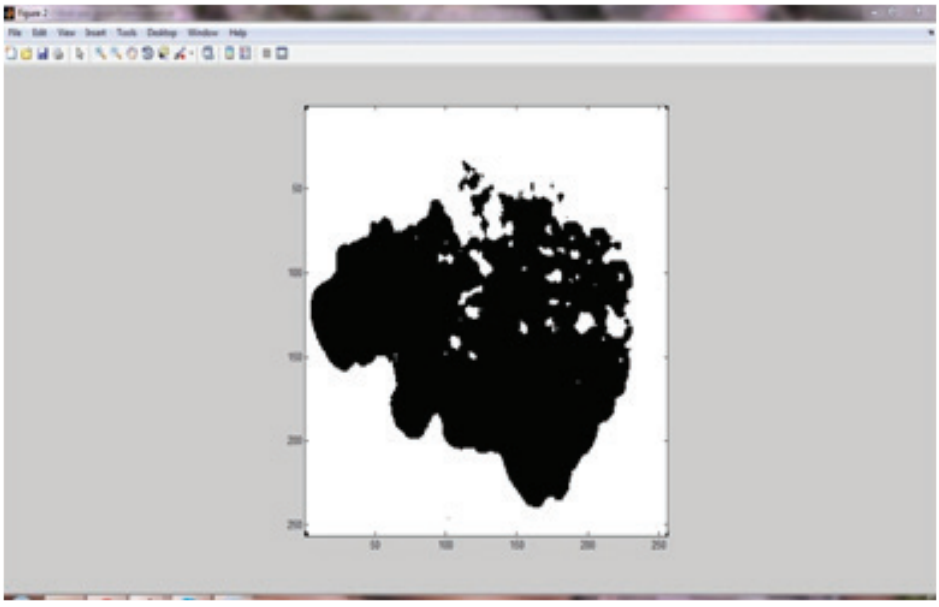

Figure 2. Segmented image using Traditional Otsu's Segmentation algorithm.

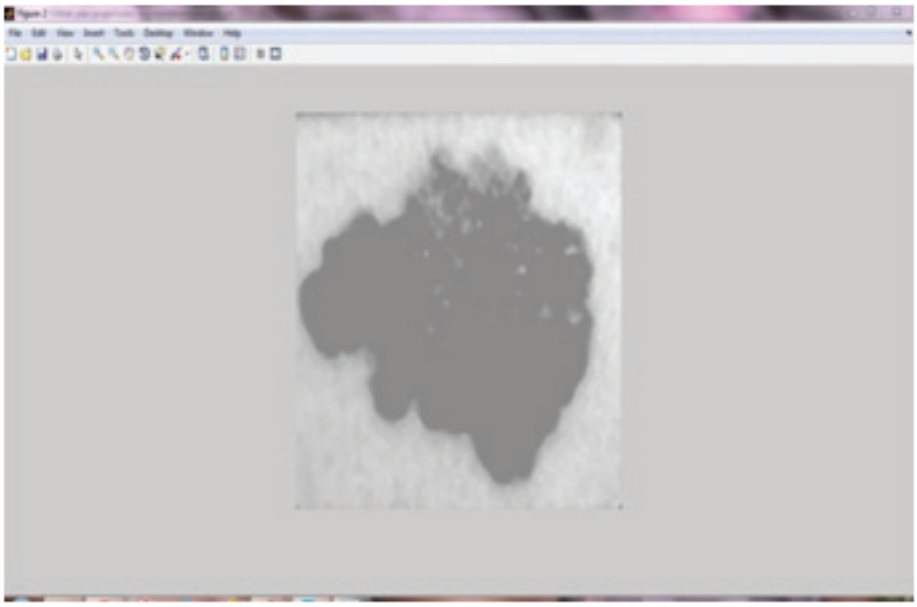

Figure 3. Normalised image.

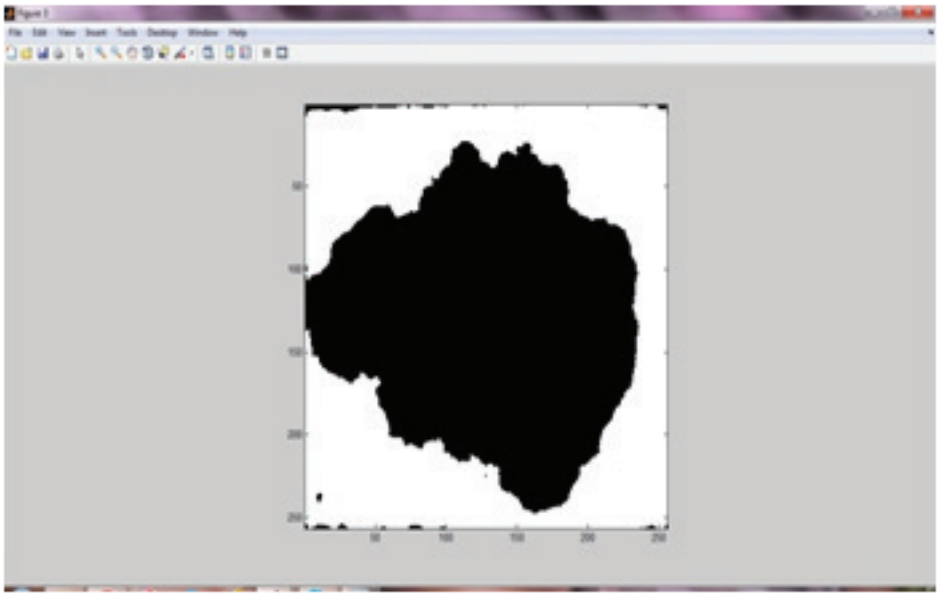

Figure 4. Segmented image using Normalised Otsu's Segmentation algorithm.

4. Comparison with State of Art

Root Mean Squared Error and Peak Signal to Noise Ratio are the two quality measures which are considered to prove that Normalised Otsu's algorithm is better than Traditional Otsu's algorithm for segmentation process. RMSE is generally defined as the square root of Mean Square Error[14]. It is a general and common method which is used for measuring quality of an image. Lower the RMSE value, better the quality of the image. PSNRis the ratio between the maximum powers of the signal to the power of noise. Higher the PSNR value betters the

Table 1. Comparison table

	Otsu's Algorithm	Normalised Otsu's Algorithm
Root Mean Squared Error(RMSE)	0.1021	0.0915
Developing skill and ability	.798	.339

quality of the image[15]. From Table 1 it is clear that the RMSE value is less when Normalised Otsu's algorithm is used to segment the image when compared to the value which is obtained on applying Traditional Otsu's algorithm for segmentation. From the same table it can also be inferred that the PSNR value obtained on applying Normalised Otsu's algorithm is more than the value which is obtained on applying Traditional Otsu's algorithm for segmentation.

5. Results

Segmentation is an important step in Computer aided Melanoma Diagnosis. Quality and accuracy of segmentation should be high. In order to obtain more accurate and clear segmented image, the image should not contain any variable illumination in it. To remove variable illumination and produce a clear segmented image, first the image is normalised to make the intensities uniform and then segmented by applying Otsu's segmentation algorithm. Normalised Otsu's segmentation algorithm makes the process simpler and also yields a better and well segmented image when compared to the image which is segmented using Traditional Otsu's segmentation algorithm. Features can be extracted more accurately from the segmented image,which is used for further classification of images.

6. Conclusion

This literature provides an algorithm which can be implemented easily for obtaining better and accurate results in the segmentation process, which provides a better and wider path for melanoma prediction. The proposed algorithm of this literature produces less error rate and high PSNR value which proves that the segmented image quality is high. When this proposed algorithm is used for segmentation, the problem of variable illumination can be overcome. When this variable illumination problem is removed,the result of the segmentation process is more accurate and clear, which provides a wider and clear way for extracting features from the segmented image in more qualified and quantified manner.

7. Acknowledgements

The authors sincerely thank the Department of Science and Technology, India for their financial support to carry out this research work. We also thank SASTRA University for providing immense resources and support for this research.

8. References

1. Premaladha J, Sujitha S, Priya M, et al. A survey on melanoma diagnosis using image processing and soft computing techniques. Research Journal of Information Technology. 2014; 6(2):65–80.
2. Singh V, Kumar R, et al. Image segmentation using soft computing. Planetary Scientific Research Center. 2011.
3. Srubar. Quality measurement of image segmentation evaluation methods. 8th International Conference on Signal Image Technology and Internet Based Systems; Naples. 2012. p. 254–8.
4. Sarkar, Haw, Logeshwaran. Morphological based technique for image segmentation. International Journal of Information Technology. 14(1):55–80.
5. Gonzalez RC, Woods RE. Digital image processing using matlab. 2nd ed. GatesMark Publishing; 2009.
6. Kang WX, Yang QQ, Liang RR. The comparative research on image segmentation algorithms. IEEE Conference on ETCS; Wuhan, Hubei, China. 2009. p. 703–7.
7. Dhawan AP, Sicsu A. Segmentation of images of skin lesions using color and texture information of surface pigmentation. Computerized Medical Imaging and Graphics. 1992; 16(3):163–77.
8. Nammalwar, Padmapriya, Ghita, et al.Integration of colour and texture distributions for skin cancer image segmentation. International Journal of Imaging and Robotics. 2010; 4(A10):86–98.
9. Vala J, Baxi. A review on Otsu image segmentation algorithm. IJARCET. 2013; 2(2):387–9.
10. Makkar P. Image analysis using improved Otsu's thresholding method. International Journal on Recent andInnovation Trends in Computing and Communication. 2(8):2122–6.

11. Saripan, Azmi, Abdullah, et al. Illumination compensation in pig skin texture using local-global block analysis. Modern Applied Science. 2009; 3(2):89–93.
12. Cai, Yang, Cao, et al. A new iterative triclass thresholding technique in image segmentation. IEEE Transactions on Image Processing. 2014; 23(3):1038–46.
13. Gonzalez RC, Woods RE. Digital image processing. 2nd ed. Beijing: Publishing House of Electronics Industry; 2007.
14. Root Mean Squared Error (RMSE). 2015 Jan 4. Available from: https://www.kaggle.com/wiki/RootMeanSquaredError
15. Peak signal-to-noise ratio2015 Jan 4. Available from: https://en.wikipedia.org/wiki/Peak_signal-to-noise_ratio