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## SELECTION OF THRESHOLD AND RE-CALCULATION OF DENSITY VALUE IN IMAGE PROCESSING

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### ABSTRACT

In this paper, we propose a different approach to calculate the threshold value by means of thresholding method which is used in image processing. After that threshold value is used according to new intensity value generation of image pixels and results are given.

### INTRODUCTION

Image segmentation is the identification or classification of the boundary points of the objects in the image. Therefore, in order to find the boundary points, segmentation can be performed taking into account the properties distinguishing these points from all other points [1]. However, identification of border points from other points is not as easy as human vision. In this work, we developed a preprocessing method that can be used as a helper in image segmentation. In the proposed method, density values are initially determined at the boundary points. Then the density value of these points is changed with new density value generation functions. Thus, it is ensured that the boundary points are different from the other points.

### Thresholding

Thresholding is one of the simplest and most popular techniques for separating an object from the background in the image [2,3]. The thresholding technique can be divided into two categories: global thresholding and local (adaptive) thresholding. At the global threshold, a fixed threshold value is used to separate the object from the background. The global threshold can be said to be a very attractive method considering the ease of use in many applications. However, local thresholding may be necessary for images that are illuminated uneven or at a certain angle [4]. Only local thresholding will be discussed in this paper.

For a pixel-based method thresholding, the threshold value must be determined in the first step. The threshold value for each image is also different because of the differences between the images. In the traditional methods, the threshold value is reached by the intensity histogram which gives the pixel-density relationship in the image. Fig. 1 shows the MR image and histogram of the human skull.

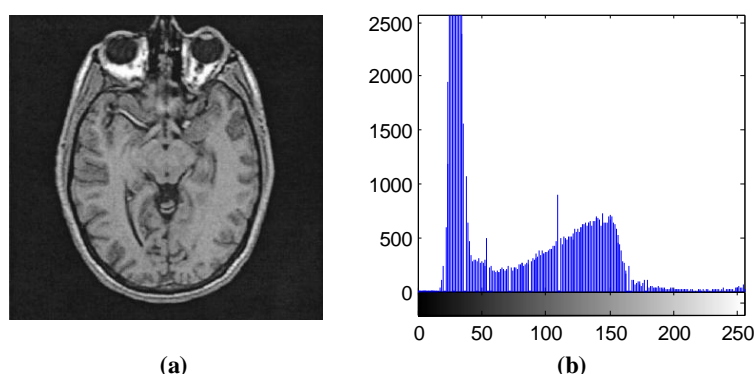


Fig 1 : (a) Original image, (b) Histogram of the image

According to histogram information, we have information about the number of pixels at the same intensity in the image. However, the calculation of the threshold value to be derived from the histogram is a process that requires high computation [5]. In the present thresholding method, the threshold value for the image in Fig. 1 is adjusted to a value between 50 and 70. Because, it is assumed that the region between the two peaks in the histogram shows the density of the pixels at the boundary of the object or objects in the image [6]. After the threshold value is

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determined, the density of the pixels with values larger or smaller than this value is changed to create a new image.

In Fig. 2.a, a threshold value of 140 is selected and the density of pixels with a larger density than this value is re-evaluated as white. In Fig. 2.b, the pixel with a smaller density than the threshold is re-evaluated as a black color (note that the gray tones within the cells are lost).

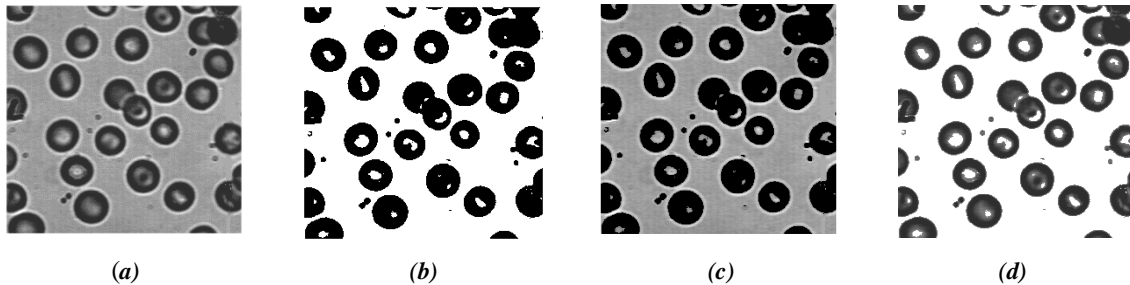


Fig 2 : a) Original image, (b) and (c) images generated by traditional thresholding methods, (d) proposed method

### Using Arithmetic Average As A Threshold

The proposed method in this study is to select the arithmetic mean of the intensity values of the pixels in the image instead of the histogram as the threshold value.

$$E = \frac{G(i,j)}{i,j} \quad (1)$$

In this equation,  $G$  is the matrix containing the density of the pixels in the image, and  $E$  is the mean value considered as the threshold value. In Fig. 3, the pixel with a density value close to the threshold  $E$  of 15 units is shown, and the other pixels are painted in white.

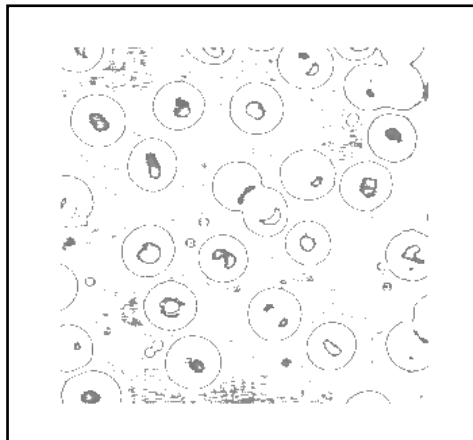


Fig 3 : The pixel whose density is close to 15 units of the  $E$  threshold value

As shown in Fig. 3, the density values at 0-15 unit distance from the threshold correspond to the border values. These 15 unit distances are chosen to show the border values.

### New Value Generation Function

In this study, it is aimed to recalculate density values of target pixels with new value production functions (NVPF) proposed. NVPF can be applied to pixels that are denser than the threshold value after the threshold value is determined, or vice versa, whose density is less than the threshold value. In Fig. 4, a function of NVPF (logarithmic incremental function [LIF]) is given, which shows a higher deviation in the regions close to the zero point and a steadily decreasing deviation value at the other points.

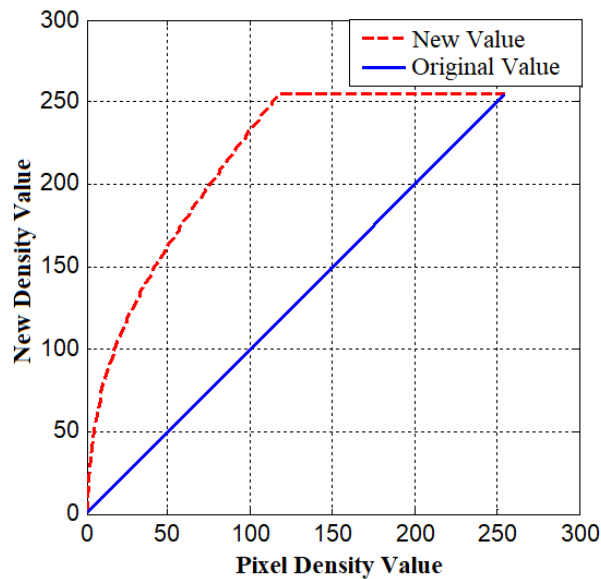


Fig 4 : The logarithmic increase function LIF

In the LIF function as shown in Fig. 4, the horizontal axis shows the actual density value of the pixel, while the vertical axis shows the new density value of the same pixel. Applying this function to the image is done not by the function shown but by adding it to the calculated threshold value of the zero point. Due to the different threshold value to be found for each image, the threshold value in the function display is assumed to be zero. When  $T$  is assumed to be the threshold value for any image, the LIF function for  $T=100$  and  $k=5$  can be represented as shown in Fig. 5. Note that the LIF function shown in Fig. 4 only affects the upper limit value. In Fig. 5, the pixel whose density is below the limit value gets new values. In addition, the effect of the value of  $k$  can be easily observed in Fig. 5.

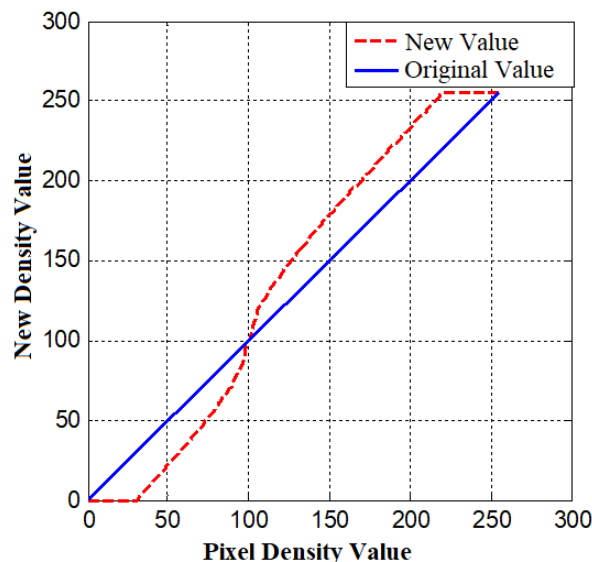


Fig 5 : New values generated by the LIF function for  $k=5$  and  $T=100$ .

Two approaches emerge when it is considered that the boundary of the segmentation is to be specified or clarified in the image. By assigning a different intensity value to the boundary points of these regions from the other points, it is necessary to make these points more apparent in the image, and to assign values farther than the density values at the point boundary points other than the boundary points. By means of these approaches, it is aimed to determine the values near the density values near the boundary points to be close to the distances, and to display both the boundaries of the image and the density values of the other points with a slight loss. For

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this purpose, the density values of the pixels in the image have been recalculated by means of the new value production functions introduced to help segment the image.

The new value generation functions can be applied in different ways depending on the image parts (the densities are larger than the threshold and the smaller spots are the threshold). The LIF function in Fig. 5, is produced to be applied to both pixels whose density is greater than the threshold value and smaller than the threshold value. The calculation of the function in Fig. 4, is shown in equation (2). Note that as the slope increases as you approach the zero point, the density values of the points near zero are more variable than others. This means that the application of this function to the image and the boundary points in the image will change more than the other points.

$$f(x) = k (\log_2 x) + x \quad (2)$$

The function obtained for different  $k$  values using the function shown in Fig. 4, the intensity is shown in Fig. 6, only with varying  $k$  values applied to the pixels over the threshold value.

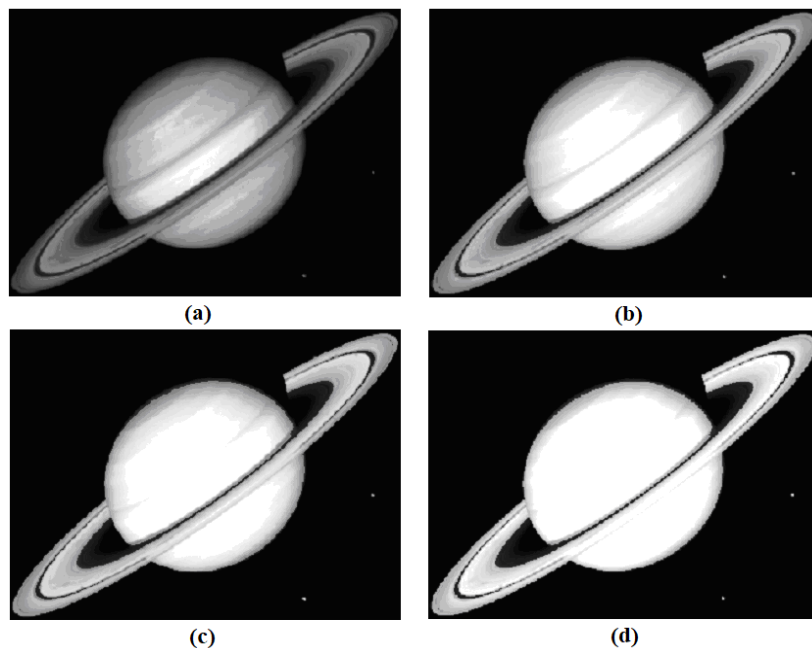
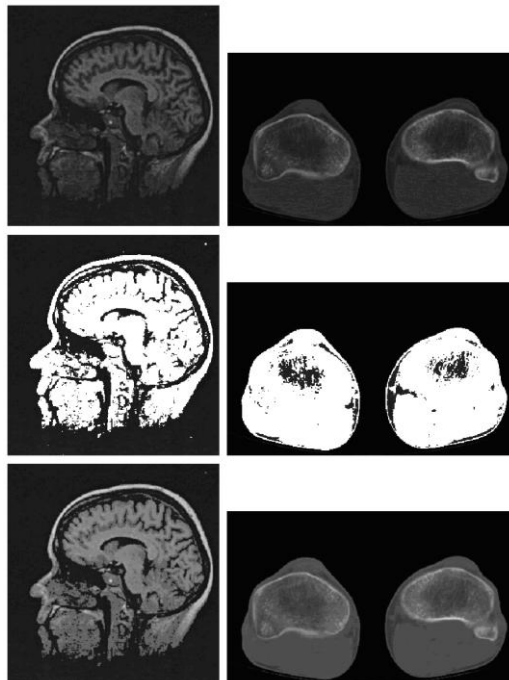


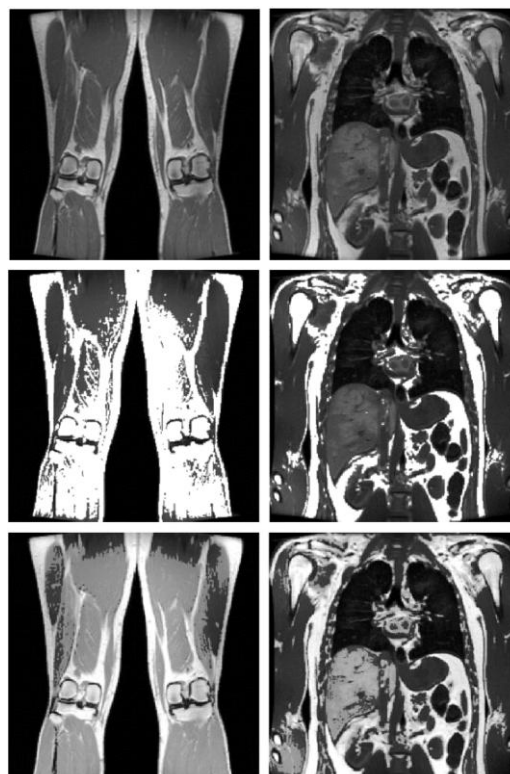
Fig 6 : (a) Original image, (b)-(d) logarithmic increase images ( $k = 1, k = 5, k = 10$  respectively)

### EXPERIMENTAL RESULTS AND DISCUSSION

In this section, we have applied the general thresholding method, which is derived from the threshold value obtained by using the histogram, and the application of the proposed method to the resultant images were compared. The images in Fig. 7 and 8 have visible differences after applying both methods. In this regard, although the proposed method uses the thresholding approach, it can also be considered as an image enhancement method by differentiating it from the thresholding methods.



*Fig 7 : On left column the human skulls, on the right is anterior tibial osteotomy in the human knee. From top to bottom each column shows; the original image, followed by a histogram-truncated image and finally, the image ( $k = 1$ ), which is thresholded by the proposed method*



*Fig 8 : MR images showing the human skull in the left column and the human chest and arms in the right. From top to bottom each column shows; the first is original image followed by the image bridged by the histogram and finally by the proposed method ( $k = 1$ ).*



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### CONCLUSION

This paper is related to automated threshold value selection. Especially arithmetic average finding method is used for calculation of threshold. This method is useful for medical or satellite images. Results have shown that presented method have been satisfied in better result according to traditional methods.

### REFERENCES

1. Kermad, C.D., Chehdi, K. *Automatic image segmentation system through iterative edge-region operation. Image and Vision Computing*, 20, 2002, 541–555.
2. Bin Y., Jain A.K. *Address Block Location on Complex Mail Pieces. Accepted for oral presentation at the International Conference on Document Analysis and Recognition, August 18-20, Ulm, Germany (1997).*
3. Kittler J., Illingworth J. *Minimum Error Thresholding. Pattern Recognition* 19(1), 1986, 41-47.
4. Solihin, Y., Leedham C.G. *The Multi-stage Approach to Grey-Scale Image Thresholding for Specific Applications, School of Computer Engineering Nanyang Technological University Nanyang Avenue, Singapore 639798.*
5. Haralick, R.M., Shapiro, L.G. *Image segmentation techniques, Computer Vision, Graphic, and Image Processing*, 29, 1985, 100–132.
6. Gonzalez, R.C., Woods, R.E. *Digital Image Processing, Addison-Wesley Publishing Company Inc., 1992.*