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Nissa Almira Mayangky ✉; Dwiza Riana; Sri Hadianti; ... et. al

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Eye Pupil Image Segmentation Conducted With Intensity Adjustment Method and Active Contour Method

Nissa Almira Mayangky,[a] Dwiza Riana,[b] Sri Hadianti,[c] Siti Nurdiani,[d] Ridan Nurfalah,[e] and Achmad Rifai[f]

Universitas Nusa Mandiri Jl.Raya Jatiwaringin No 2, Cipinang Melayu, Makassar, Jakarta Timur

[a] *Corresponding author:nissa.nky@nusamandiri.ac.id*
[b] *Electronic mail: dwiza@nusamandiri.ac.id*
[c] *Electronic mail: sri.shv@nusamandiri.ac.id*
[d] *Electronic mail: siti.sxd@nusamandiri.ac.id*
[e] *Electronic mail: ridan.rlh@nusamandiri.ac.id*
[f] *Electronic mail: achmad.acf@nusamandiri.ac.id*

Abstract. The segmentation of the eye pupil is still a trendy research topic in the field of iris recognition, because the low accuracy of this step will damage or reduce the efficiency of the iris recognition system. Therefore, it is necessary to emphasize research in the segmentation process to show accurate and appropriate results. This depends on the results of the accuracy shown from the detection of the center of the pupil of the eye. The aim of this research is to design a system that can segment the pupil area to support the application of the iris recognition system using the median filtering method at the pre-processing stage to improve image quality and remove noise in the image for accuracy and support segmentation results using the active contour method. This experiment was carried out using iris images and the results showed that the proposed method was able to segment pupil images with a high level of accuracy.

INTRODUCTION

Humans are individuals who have characteristics such as self-recognition and identification. Characteristics or human characters are commonly used to distinguish a person from others, one of which can be through biometric recognition [1]. Due to advances in technology and the increasing demand for security systems, biometric methods based on personal verification and identification methods are now gaining more and more attention [2]. The types of biometrics include facial, fingerprint, ear, and iris recognition systems. The eye is one of the five human senses which has a part called the iris. The iris is located behind the cornea and in front of the lens which has the function of regulating the size of the pupil. The process of self-recognition in humans can usually be identified through the pupil of the eye with certain processes and methods. However, the case of pupillary segmentation is a topic that is widely discussed in the field of iris recognition. If the results obtained from previous research are not good, this step will damage or reduce the effectiveness of the iris recognition system [3]. Every human being has different biometric patterns, it can be used to identify a person through the pupil of the eye. Detection of the center of the pupil of the eye needs to be considered in the segmentation process in order to get high accuracy results [4]. The purpose of this study is to design a system that can segment the pupillary area to support the iris recognition system, using the IntensityAdjustment method in pre-processing to reduce image contrast and eliminate object image noises for accuracy and improve the quality of segmentation results using the active contour method., whereas in the previous study [5] segmentation of the iris has been carried out using the thresholding and Otsu methods with less than perfect segmentation results. In research [6] pupillary segmentation has been completed by processing the RGB color channel and detecting the edge of the filling hole. Research [7] of pupil segmentation has been completed by processing RGB color channels and thresholding edge detection. In this study, pupillary segmentation was carried out by testing the active contour segmentation method using intensity adjustment-based preprocessing and without intensity adjustment preprocessing.

METHODS

The system built in this study includes these steps described in the flowchart image in Figure 1 below, the steps are pupil segmentation using intensity adjustment and active contour methods.

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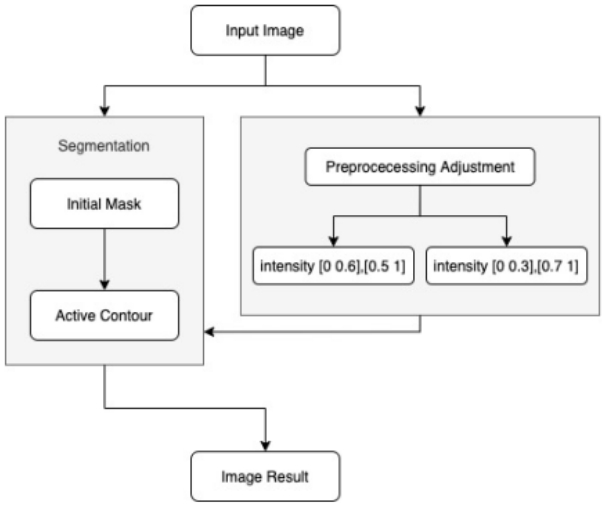

FIGURE 1. System Workflow Diagram

Input Images

This pupil segmentation method is implemented using an iris image from a public database taken from the Biometrics Ideal Test dataset at http://biometrics.idealtest.org CASIA (Chinese Academy Of Sciences Institute of Automation) image Iris Interval V4.0 in the form of a grayscale iris image with a resolution of each image is 320 x 280 pixels and exploring the empirical results manually shows efficient and accurate results. The total image used is 91 images, both right eye and left eye. An example of a Biometric image is shown in Figure 2.

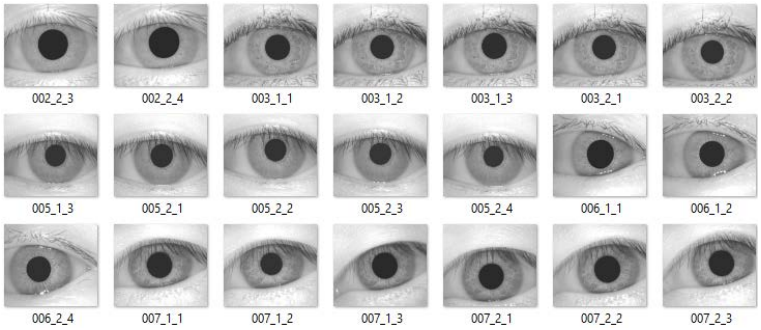

FIGURE 2. System Workflow Diagram

Segmentation

This stage is a segmentation step where the image that has been successfully inputted is detected so that only the pupil of the eye can be read. This stage uses mask initialization and active contour method.

Mask Initialization

This stage performs the initialization of the mask to make it easier for the image segmentation process, starting with the pupil segmentation process, the area of the pupil is used as the initialization of the mask. An example of an image can be seen in Figure 3.

Active Contour Method

Active contour is a segmentation method using a closed curve model that can move wide or narrow [4]. The process in the Active Contour model is to create a mask or initial line around the object so that the energy from the image object (External) will cause the curve to shrink and follow the shape of the object. The curve will move closer to the object because of the energy contained in the curve (Einternal) [6]. The Active Contour method is used because it is simple to run and implement, relatively fast, easy to adapt, and widely used [6]. Active contour has advantages such as being able to detect lines and curves that are not covered and can detect objects with different intensities. In addition, the Active Contour method itself is used because of its advantages, namely it can detect all contours, no matter where the initial contour starts in the image [8]. Active Contour is also a segmentation approach that uses a concept such as a balloon in which an object is inserted [9]. The balloon will move towards the object boundary through iterations until the balloon stops moving. This is because of the energy minimization process in Active Contour. Active Contour does not segment based on pixels, but through the movement of the curve. The movement of the curve itself is influenced by the parameters alpha and beta which will stop at the edge of the object. The object constraint is the minimum value of the energy function [10] The energy function not only contains information about edges, but also contains properties that control the movement of the curve. Active contour as a controlled set of coordinate points on the contour where the parameters are defined [11].

FIGURE 3. Image Result Of Active Contour Method With Mask Initialization

Intensity adjustment method for active contour segmentation

Intensity adjustment is a method of point operation in image enhancement carried out by modifying the histogram of the input image to match the expected characteristics. Intensity adjustment works by doing a linear mapping of the intensity value in the initial histogram to the intensity value in the new histogram [12]. In this study, the intensity adjustment method was carried out to improve image quality so that it could be perfectly segmented using the active contour method as shown in Figure 4.

RESULT

The pupillary image segmentation was successfully carried out with several trials, including:

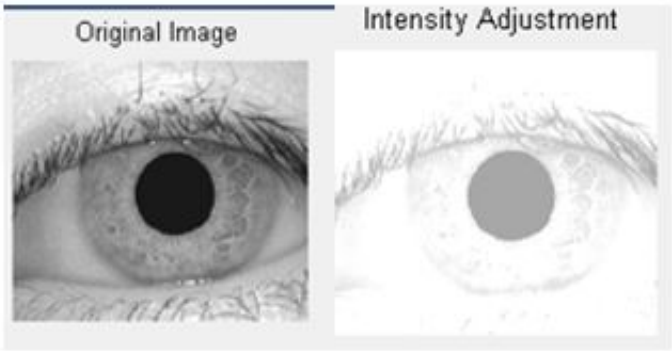

FIGURE 4. Image Result of Intensity Adjustment Method

Input Image

The first trial was carried out on 26 images that were tested directly using active contour segmentation, then the second trial, the same 26 images were tested by doing preprocessing using the intensity adjustment method, which after preprocessing was carried out segmentation using active contour segmentation with the results of 26 images contained 22 images successfully segmented perfectly.

Active Contour Method

This section is the first trial where the input image is segmented using the Active Contour Method with the input image of the iris. The result is that the pupil is not perfectly segmented, in the first trial the eyelashes were also segmented as shown in Figure 5.

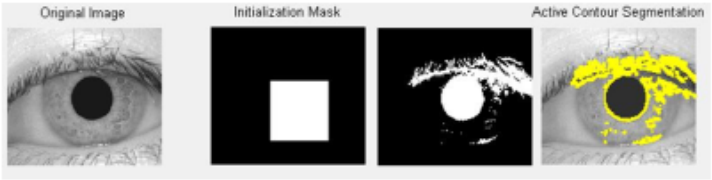

FIGURE 5. The Input Image of The Iris (Left), The Results Of The Active Contour Method (Right)

Test Phase of Active Contour Method with Intensity Adjustment Method

This section conducts an initial trial of prepossessing using the Intensity Adjustment method which works by performing a linear mapping of the intensity values in the initial histogram to the intensity values in the new histogram.[12], with intensity values [0 0.6],[0.5 1] and segmentation of Active Contour Method. This process was examined on 26 eye images, 11 images or 42.3%were perfectly segmented and 15 images or 57.7% were not well segmented. Examples of the results of the initial prepossessing trial using the Intensity Adjustment method with intensity values [0 0.6], [0.5 1] can be seen in Figure 6. In the second trial step with Intensity Adjustment, the way it works is to do a linear mapping of the intensity value in the initial histogram to the intensity value in the new histogram [12], with the intensity value [0 0.3][0.7 1] from 26 eye images, obtained 24 images or 92.3% perfectly segmented and 2 images or 7.7%

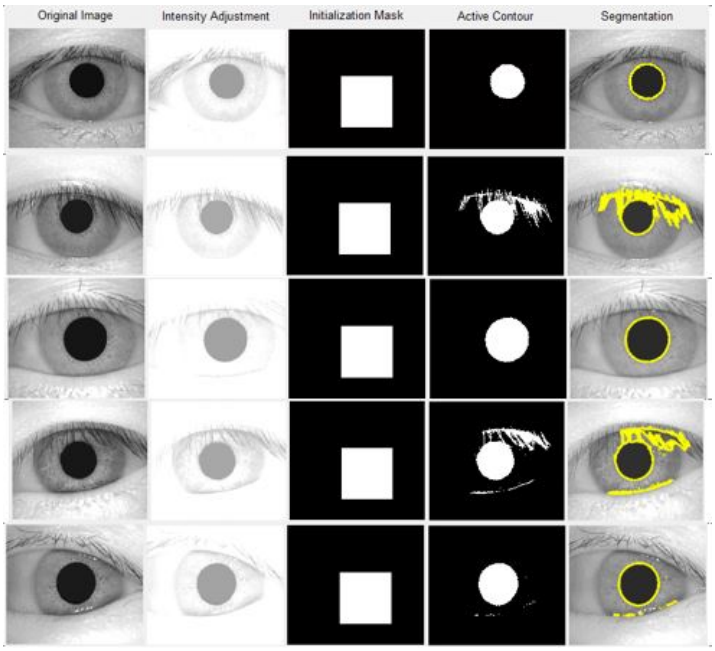

FIGURE 6. Intensity Adjustment Method Test with intensity values [0 0.6],[0.5 1]

not well segmented, with these results the intensity value [00.3][0.7 1] is applied on all images totaling 91 images. Examples of the results of the second stage can be seen in Figure 7. The second trial yielded good results, resulting

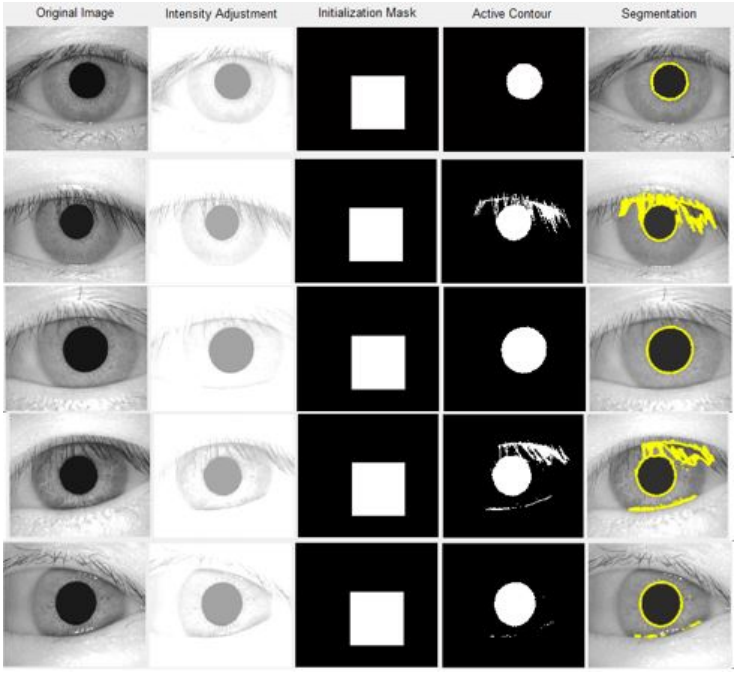

FIGURE 7. Test the Intensity Adjustment Method with the intensity value [0 0.3][0.7 1]

in the third trial of the Intensity Adjustment method with the intensity value [0 0.3][0.7 1] applied to 91 eye images,

obtained 83 imagesor 91.2% perfectly segmented and 8 images or 8.8% not well segmented . The result of this step makes the pupil image which was previously not perfectly segmented, using preprocessing intensity adjustment the pupil image becomes perfectly segmented. Examples of the results of pupillary image segmentation that have been preprocessed can be seen in Figure 8.

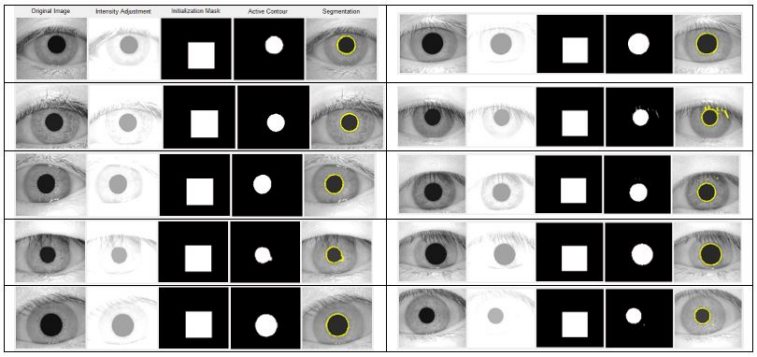

FIGURE 8. Application of the Intensity Adjustment Method with the intensity value [0 0.3][0.71]

CONCLUSION

Based on the analysis results that have been studied on 91 images related to pupil segmentation, it can be concluded that Iris Image Identification depends on accuracy in detecting the pupil, using the Intensity Adjustment image improvement method with the intensity value [0 0.3][0.71] in pre-processing it turns out that it can reduce the contrast in the eye image and eliminate image noise, it makes the pupil segmentation process using the active contour method better accuracy in segmentation, obtained 83 images or 91.2% perfectly segmented and 8 images or 8.8% not well segmented . In the future, it is hoped that this research can be developed so that accuracy results can be improved, research can use more datasets so that they can get better results.

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