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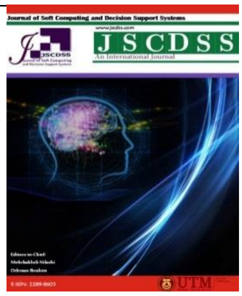

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Morphological-Edge Detection Approach for the Human Iris Segmentation

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Abstract

In the new millennium, technology has become more interesting issues and it has salient progress. Therefore, iris recognition systems attract many attention not only because of its huge applications such as security but also due to its importance in our today's life. Even though, a number of researches have been done in this field; due to the large number of demands from every places like banks, airports, hospitals, market places and so on, it deserves more considerations. In this paper, a new segmentation method is performed in order to segment an exact part of the eyes e.g. iris area. Then, for extracting the top and bottom texture, calculating the texture images, local entropy of grayscale image is utilized. After that, Otsu's method is applied for globalizing image threshold. Finally, Haar wavelet transform is applied for feature extraction step. We use CASIA-Iris V3 database for our experimental results.

Keywords: Iris recognition; Acquisition; Segmentation; Biometrics; Morphological operators

1. Introduction

In today's life of human, they will face numerous advancements of cutting-edge technologies (Ricanek et al., 2010). Among many of these, individuals need more reliability and security in all of the facets of their life. So, biometric traits brought this for facilitating the usage of almost everything for people (Niinuma et al., 2010). The process of identification by means of biometric traits uses the behavioral and physical features of human (Reid et al., 2013) which it comprises iris (Ahmadi and Akbarizadeh, 2018), vein (Yang et al., 2014), palm (Zhu and Zhang, 2010), face (Park, and Jain, 2010), pupil (Elhoseny et al., 2018), fingerprint (Cappelli et al., 2015), vessel (Perera et al., 2015), etc. These features gain lots of popularity among many scholars and researchers around the world and they have been utilizing these traits for their researches (De Marsico et al., 2015). Furthermore, by performing new machine learning (De Marsico wt al., 2016) and the other artificial intelligence methods (Alvarez-Betancourt and Garcia-Silvente, 2016), they have been trying to do their best and obtain more applicable and reasonable results for future studies (Raffei et al., 2015).

From the popularity point of view, it is worthwhile to say that, iris trait has gained more attention among the researchers and companies (Othman et al., 2016) and it has appeared as a trustable device in order to distinguish people (Ahmadi and Akbarizadeh, 2017). The reason which is behind this is the factors that made the iris distinguishable among other biometric traits, these features are uniqueness (Raghavendra and Busch, 2015), reliability (Chen et al., 2016), constant pattern (Phillips et al., 2007), genetic independence (Hollingsworth et al., 2011), and so forth.

The common iris recognition framework consists of the following steps (Ahmadi and Akbarizadeh, 2015): (1) Image acquisition (Pillai et al., 2011), (2) pre-processing (Kang, 2010), (3) feature extraction (Ahmadi and Nilashi 2018), and (4) feature matching (Belcher and Du, 2009; Ahmadi and Akbarizadeh, 2017).

The rest of this paper is summarized as follows. In Section 2, background and literature review are described. Section 3 provides our proposed method and results. Finally, conclusion is presented in Section 4.

2. Background and literature review

In this section we provide a literature which consists of the numerous published papers related to iris segmentation, especially with morphological operator. In (Umer et al., 2015), they proposed a novel iris recognition system. Based on their work, the applied Restricted Circular Hough Transformation (RCHT) approach for iris segmentation; then, they applied multi-scale morphologic operator for iris feature extraction step, and finally, the utilized support vector machine (SVM) and fusion for the classification step. They tested their study on four well-known iris databases: (1) UPOL, (2) MMU1, (3) IITD, and (4) UBIRIS. The author of this paper (Wan et al., 2013), applied anisotropic diffusion for non-ideal iris segmentation which is circle-based. They also used Laplace pyramid (LP) in order to diminish the computational complexity of the both interior and exterior boundaries localization. Their method was tested on CASIA-IrisV3-Interval, MMU1, UBIRIS 1.0, and CASIA-IrisV3-Lamp and according to their experimental results, they got 96.90% segmentation ratio.

Luengo-Oroz et al. (2010), presented a fast iris segmentation approach on undetermined noisy iris images based on mathematical morphology. Furthermore, NICE-I datasets was used for testing their work. Jalilian and Uhl (2017), applied a novel iris recognition approach based on fully convolutional encoder-decoder networks (FCEDNs). In the paper presented by Abdullah et al. (2016), they performed an active contour force for iris segmentation following by a non-circular normalization for iris segmented iris. Furthermore, they used CASIA V4.0, MMU2, UBIRIS V1, and UBIRIS V2 iris datasets for their experimental results.

3. Proposed method and results

For performing this approach, after pre-processing step, at first, local entropy of grayscale image is utilized. Then, rough mask is created in order to segment the textures for the bottom texture and threshold the rescaled image. After that, for smoothing the edges process and closing all the open holes in the object, morphologically close image is employed, and selected a 9-by-9 neighborhood as it chosen by local entropy of grayscale image. Fig. 1 demonstrates the block diagram of our proposed method.

3.1 Image Segmentation

The main step which is the most important step in iris recognition is the image segmentation. Several image quality measures have been assessed that are comprises dilation ratio (Fairhurst and Erbilek, 2011) and occlusion (Pundlik et al., 2008); in addition, in order to make a conversion of the matrix to grayscale image and create a texture image, local entropy (Proença, 2014) of grayscale image is used. Then, rough mask is created in order to segment the textures for the bottom tissue; after that, threshold (Jeong et al., 2010) the rescaled image. Subsequently, for smoothing the edges process and closing all the open holes in the object, morphologically close image (Vincent, 1994) is employed and then selected a 9-by-9 neighborhood as it was also chosen by local entropy of grayscale image. Finally, for extracting the top and bottom of the texture, and calculating the image tissue, local entropy of grayscale image is utilized. Furthermore, Otsu's method is applied for globalizing image threshold (see Fig. 2).

3.2 Iris Localization

From the beginning, the grayscale format (Rakshit and Monro, 2007) is performed in the captured mages. Then, the holes (the hole is the region which dim pixels surrounded light pixels in the image) that exist in the gray level images must be identified. After that, in order to make an edge map on this gray level image, Canny edge detection operator (Othman et al., 2019) which is an effective method is utilized. Subsequently, morphological operators (de Mira et al., 2015; Ahmadi and Akbarizadeh, 2016) are used to eliminate small objects. Following that, the pupil and limbic boundary are detected morphologically. Afterwards, the reflections of the pupil are removed by creating a mask. Later, the connected component labeling (Solomatin et al., 2018) on binary images is carried out. Succeeding that, in order to omit the noise, the least-squares fit of ellipse to 2D points (Mulleti and Seelamantula, 2015) is done, and pupil and limbic boundary are detected. And finally, the iris area is discovered (see Fig. 3 and Fig. 4).

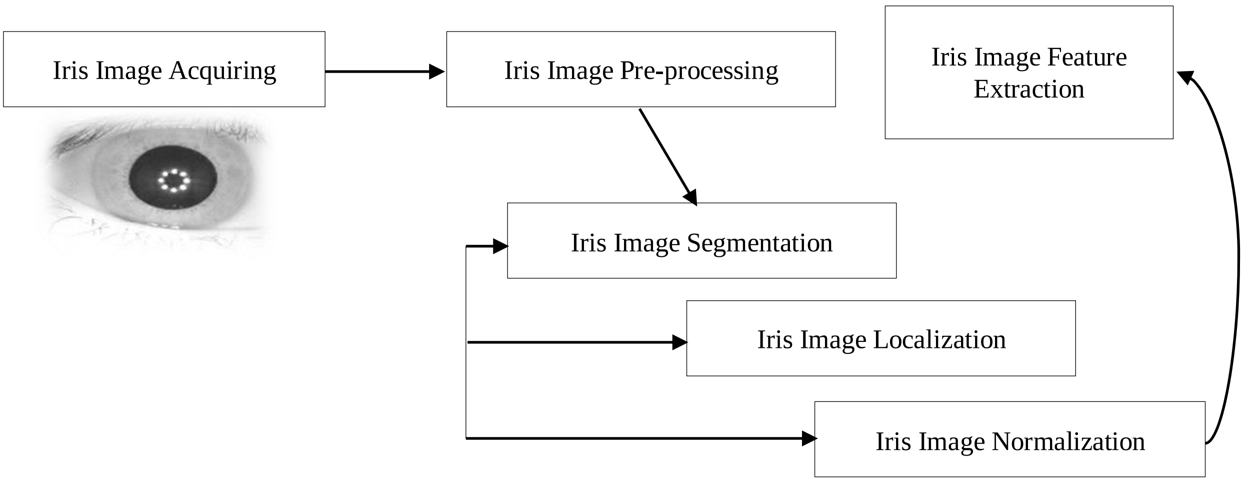

Fig. 1. Block diagram of our proposed method

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3.3 Image Normalization

After segmentation process of the iris area and it is separated from eye image completely, then in order to calculate the similarity, the iris area is transformed in the next step for obtaining the constant dimensions. For this normalization process, Duugman rubber sheet model (Ahmadi and Nilashi, 2018) is performed as it gives wonderful result for this process. Fig. 5 shows the normalized iris image.

3.4 Feature Extraction

In this step, for obtaining the iris features, Haar wavelet transform is used in order to extract the iris tissue precisely. This is because of the low computational requirements of this method and also it has been widely utilized for both image processing and pattern recognition (Jillela and Ross, 2015; Tapia et al, 2016). It disintegrates the iris data in some sections, so that it is usable in different resolutions.

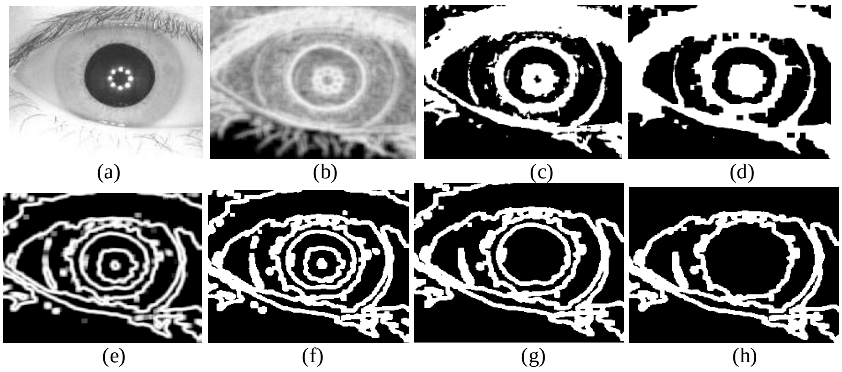

Fig. 2. (a) Original resized image. (b)) Local entropy of grayscale. (c) Create rough mask. (d) Morphologically close image. (e, f, g, h) Local entropy of grayscale image, and Otsu's method

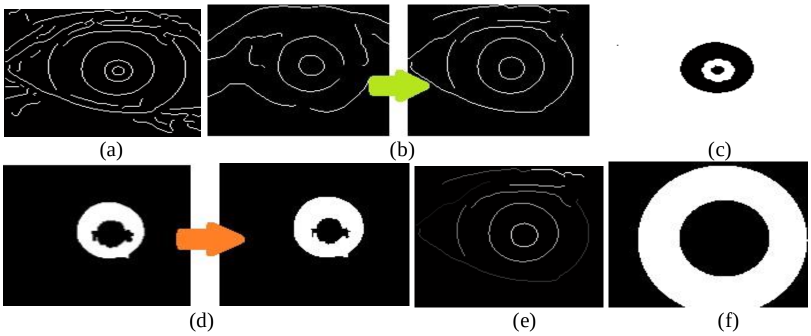

Fig. 3. Canny edge detection. (b) Remove small objects morphologically. (c) Robust pupil and limbic boundary detection, apply morphological operations on binary images. (d) Pupil boundary detection part mask reflections first. (e) Label connected components on binary image. (f) iris area

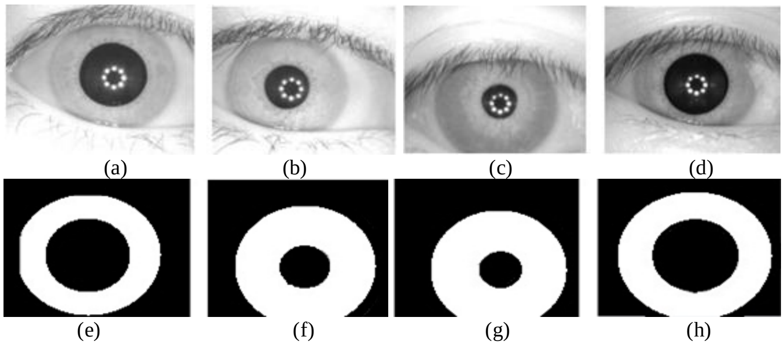

Fig. 4. Accurate iris localization of CASIA-Iris V3 database: (a, b, c, and d) are the first image from first, second, third, and fourth person, respectively. (e, f, g, and h) are the localized iris detection for image a, b, c, and d, respectively.

Fig. 5. Normalized iris image

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4. Conclusion

In this study according to the fact that segmentation step is quite prominent for iris recognition framework, we presented a novel approach towards iris segmentation. After we obtained the iris image, then we used pre-processing steps that consists of segmentation, localization, and normalization steps. In segmentation step, we utilized local entropy of the grayscale iris image; then, we created a rough mask; after that we used morphological operators and Otsu method. In the next step which is localization, we applied Canny edge detection method. Then, we omitted the tiny objects morphologically. Afterward, we performed a detection approach for pupil and limbic boundary and we applied morphological operators on the binary iris images. Finally, we utilized connected component labeling method on the binary iris images. Last but not least, in normalization step, in order to achieve a normalized iris image, we employed Duugman rubber sheet model. In the feature extraction step, we uses Haar wavelet transform method for feature extraction step and for our experimental results, we used CASIA-Iris V3 dataset.

In the future study, it is worthwhile to improve iris segmentation by applying some of the artificial intelligence methods like Particle Swarm Optimization (PSO) algorithm, Neuro-Fuzzy method (Nilashi et al., 2019a; Nilashi et al., 2019b; Nilashi et al., 2015; Yadegaridehkordi et al., 2018), hybrid Artificial Neural Networks (ANNs), Decision Trees (Nilashi et al., 2017a; Nilashi et al., 2018; Nilashi et al., 2017b) and ensemble learning approaches (Nilashi et al., 2019c). As the segmentation step is one of the important part in iris recognition system; so, it must apply very intelligence methods for not only obtaining the best results in matching step, but also boosting the accuracy rate.

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