

## Iris Recognition based on Pupil using Canny edge detection and K-Means Algorithm

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### Abstract

In eye authentication process, the pupil detection is most crucial step to recognize the eye. In eye, iris and sclera are used as the previous inputs using to recognize the eye with different mechanisms like segmentation combining with different versions. The inner edge in the eye is not a normal circle, which may create problem in accurate recognition. In segmentation process, if the image is having less texture then it leads to iris legacy. In this paper, we concentrate only on pupil to recognize the eye. To find the edges in the image we propose canny edge detection method, to reduce the noisy data in the image and detecting the edges. After detecting edges, those images are stored in CASIA database. Secondly, the K-means method is to identify the nearest pupil edge images from the database for the given input image. The results show that identifying pupil is better method to recognizing the eye and raising the recognition accuracy.

**Key words:** Iris Recognition, Pupil Detection, Canny edge detection, Canny edge detection algorithm, K-means algorithm.

### 1. Introduction

Identification of individuals based on biometric systems, by increasing focus on security throughout the world, has been so far increasing. The biometrics system provides reliable identification by examining the physical or behavioral characters of human beings [1] which are unique among all individuals. In identification process the biometric systems are deploying either enhancing the security and reliability, or enhancing the convenience and efficiency, of an identification process. Based on uniqueness and stability of the biometrics during human's lifetime, it has been utilized as a convenient method for the identification process for many years. Some of biometric applications are finger prints, voice, retina, signature, palm, face, DNA, ear and iris. Among these iris is one of the better authentication method and it has complex characteristics as an important, convenient and non-invasive. Iris is a ring like chromatic texture between the black central pupil and white colored sclera in the human eye. Complex characteristics exist in iris

pattern exhibit the iris as an important, convenient and non-invasive natural identification means. In recent years, iris is more being utilized in identification systems. In historical viewpoint, iris was proposed originally as a reliable biometrics in 1987 by L. Form [2]. After that, Daugman given Daugman's theory based on the 2 d Gabor filter phase quantification and the code identification system [3]. Wildes continue his theory based on the multiscale Gaussian filter embedded iris identification system [4]. Boles recommended a method based on the wavelet transformation of the iris recognition algorithm [5]. In Boles and Boashash's system [6], iris images are analyzed in a 1-D dyadic wavelet transform in different resolution levels, the feature vector of the iris image was extracted from the wavelet results. Chung-Chih Tsai [7] given iris segmentation based on possibilistic fuzzy logic method to identify the local vectors. The existing algorithms are using two circular templates to identify the eye. But they are not in a standard circle shape, it leads to iris legacy and difficult to find proper identification.

In this paper, we propose canny edge detection method to identify the iris and pupil boundaries by removing the noisy data from the captured image of iris. To match the input image from the database we

propose K-means algorithm to match the exact image for the given input data, by making input pupil as centric and find the related pupil form the images. Using centric method it matches the images based on the pupil locations from the eye images. This gives the effective matching technique to detect the pupil and it can raise the accuracy of iris recognition. CASIA is iris database to give the better results to detect pupil location form the images in database.

## 2. Canny Edge Detection Algorithm

The canny edge detection method is to find the iris and pupil boundaries from the captured image. This gives the effective edges of eye. So we can get the exact pupil edge to detect the image [8],[9].

The algorithm runs in 5 separate steps: They are Smoothing, Finding, gradients, Non-maximum suppression, Double thresholding, Edge tracking by hysteresis.

### 2.1 Smoothing

It is inevitable that all images taken from a camera will contain some amount of noise. To remove that noise is mistaken for edges, noise must be reduced. So in the early stage only the image is smoothed by applying a Gaussian filter. The main aim of smoothing is to remove the noise from the blur images.

### 2.2 Finding gradients

When the grayscale intensity of the image is changed to find the edges basically canny algorithm is used. Those areas are found by determining gradients of that image. From the smoothed images the gradient points are determines each pixel by applying Sobel-operator. First step is to approximate the gradient in the x- and y-direction respectively by applying the kernels.

The gradient magnitudes (also known as the edge strengths) can then be determined as an Euclidean distance measured by applying the law of Pythagoras as shown in Equation (1). It is sometimes simplified by applying Manhattan distance measure as shown in Equation (2) to reduce the computational complexity. The Euclidean distance measure has been applied to the test image.

$$|G| = \sqrt{G_x^2 + G_y^2} \quad (1)$$

$$|G| = |G_x| + |G_y| \quad (2)$$

Where:  $G_x$  and  $G_y$  are the gradients in the x- and y-directions respectively.

An image of the gradient magnitudes indicates the edges quite clearly. However, the edges are typically broad and do not indicate exactly where the edges are. To make it possible to determine this (see Section 2.3), the direction of the edges must be determined and stored as shown in Equation (3).

$$\theta = \arctan \frac{G_y}{G_x} \quad (3)$$

### 2.3 Non-maximum suppression

It is to convert the blurred edges in the image of the gradient magnitudes to make sharp edges. Basically this is done by preserving all local maxima in the gradient image, and deleting everything else. The algorithm is for each pixel in the gradient image:

1. Round the gradient direction  $\theta$  to nearest coordinate, corresponding to the use of an 8-connected neighborhood.
2. Compare the edge strength of the current pixel with the edge strength of the pixel in the positive and negative gradient direction.
3. If the edge strength of the current pixel is largest; preserve the value of the edge strength. If not, suppress (i.e. remove) the value.

### 2.4 Double thresholding

The edge-pixels remaining after the non-maximum suppression step are marked with their strength pixel-by-pixel. Some of these will probably be true edges in the image, but some may cause noise or color variations for instance due to rough surfaces. The simplest way to distinguish between these would be to use a threshold, and then only strongest edge value would be preserved. Edge pixels stronger than the high threshold are marked as strong, edge pixels weaker than the low threshold are concealed and edge pixels between the two thresholds are marked as weak.

### 2.5 Edge tracking by hysteresis

Strong edges are interpreted as "certain edges", and can immediately be included in the final edge image. Weak edges are included if and only if they are connected to strong edges. The logic is of course that noise and other small variations are unlikely to result in a strong edge. Thus strong edges will only be due to true edges in the original image. The latter type will probably be distributed independently of edges on the entire image, and thus only a small amount will be located adjacent to strong edges. Weak edges due to true edges are much more likely to be connected directly to strong edges.

Edge tracking can be implemented by BLOB-analysis (Binary Large Object). The edge pixels are divided into connected BLOB's using 8-connected neighborhood. BLOB's containing at least one strong edge pixel is then preserved, while other BLOB's are concealed.

### 3. Effect of K-Means algorithm on pupil detection

To identify the pupil in the image we find the edges as shown in previous algorithm. To recognize the pupil from the K-means is one of the simplest unsupervised learning algorithms that solve the well known clustering problem. The procedure follows a simple and easy way to classify a given data set through a certain number of clusters (assume k clusters) fixed a priori. The main idea is to define k centroids, one for each cluster. These centroids should be placed in a cunning way because of different location causes different result. So, the better choice is to place them as much as possible far away from each other. The next step is to take each point belonging to a given data set and associate it to the nearest centroid. When no point is pending, the first step is completed and an early groupage is done. At this point we need to re-calculate k new centroids as barycenters of the clusters resulting from the previous step. After we have these k new centroids, a new binding has to be done between the same data set points and the nearest new centroid. A loop has been generated. As a result of this loop we may notice that the k centroids change their location step by step until no more changes are done. In other words centroids do not move any more. Finally, this algorithm aims at minimizing an *objective function*, in this case a squared error function. The objective function

$$J = \sum_{j=1}^k \sum_{i=1}^n \|x_i^{(j)} - c_j\|^2$$

Here based on the pupil, the iris identification process runs. The input image is go to the related color set in that the image edges are used to match the same edge form the nearest image edges. It continues till it finds the exact image. In this process we use images N, input image as K to make centric and match with the near images.

#### How the K- means effect on iris RGB colors

The processing steps to identify the iris RGB color to the image. Initially it reads the image from the database. Choosing the input image as K image to as centroid to find the color. After that it concentrate on the pupil to match the edges from the nearest images and find the exact image to the input data as shown in the Figure 3.1.

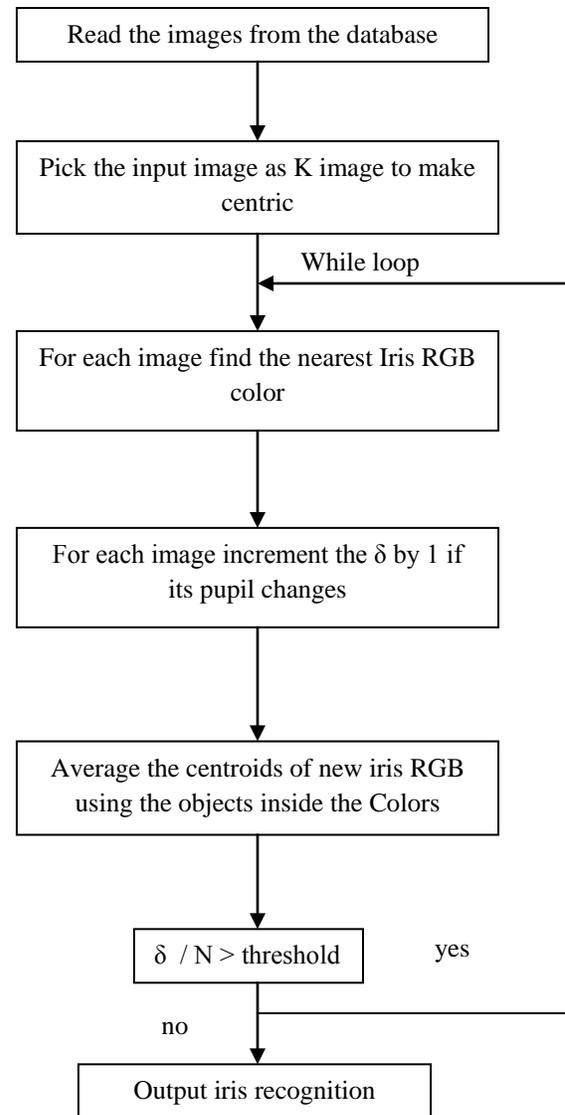


Figure 3.1 Process of Recognition of pupil

The above figure shows the process of identifying the pupil according to the iris RGB color.

authentication is done. If not the image is unauthenticated.

**K-means algorithm effect on pupil identification using iris RGB colors**

N: number of images  
 K: number of RGB colors in iris

Image [N]: array of images  
 IrisRGB [K]: array of RGB centers  
 pupil [N]: array of image pupils

Kmeans\_IrisRGB( )

1. while  $\delta/N > \text{threshold}$
2.  $\delta \leftarrow 0$
3. for  $i \leftarrow 0$  to  $N-1$
4. for  $j \leftarrow 0$  to  $K-1$
5.  $\text{distance} \leftarrow | \text{images}[i] - \text{IrisRGB}[j] |$
6. if  $\text{distance} < d_{\min}$
7.  $d_{\min} \leftarrow \text{distance}$
8.  $n \leftarrow j$
9. if  $\text{pupil}[i] \neq n$
10.  $\delta \leftarrow \delta + 1$
11.  $\text{pupil}[i] \leftarrow n$
12.  $\text{new\_irisRGB}[n] \leftarrow \text{new\_irisRGB}[n] + \text{images}[i]$
13.  $\text{new\_irisRGB\_size}[n] \leftarrow \text{new\_irisRGB\_size}[n] + 1$
14. for  $j \leftarrow 0$  to  $K-1$
15.  $\text{IrisRGB}[j][*] \leftarrow \text{new\_IrisRGB}[j][*] / \text{new\_IrisRGB\_size}[j]$
16.  $\text{new\_IrsiRGB}[j][*] \leftarrow 0$
17.  $\text{new\_IrisRGB\_size}[j][*] \leftarrow 0$

After completion of identifying color, it go to that color images and identify the edges of pupil and iris which are nearest to that image. In Figure 2. It shows how to match each image with pupil edge, if the image is found with the exact edge then the

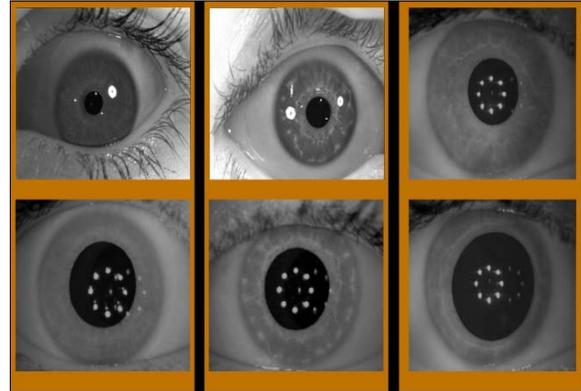


Figure 2 Iris recognition based on the pupil identification

**4. Applications**

The most popular biometric authentication scheme employed for the last few years has been Iris Recognition. The main applications are entry control, ATMs and Government programs. Recently network companies have realized the advantages of biometric authentication for networks and offer products to achieve this scheme. Products offered include fingerprint analysis, iris recognition, voice recognition or combinations of these. However widespread use of biometric as a means of authentication has not yet been fully realized.

Using iris recognition ATM, a customer simply walks up to the ATM and looks in a sensor camera to access their accounts. The camera instantly photographs the customer's iris. If the customer's iris data matches the record stored in a database access is granted. At the ATM, a positive authentication can be read through glasses, contact lenses and most sunglasses. Iris recognition proves highly accurate, easy to use and virtually fraud proof means to verify customer's identity.

In 1996 the prison in USA became the first correctional facility to use iris scanning. Sometimes the facility would need to release a prisoner on short notice and could not wait for the fingerprint tests. An iris scan is similar to taking a photograph and can be performed from about 10 cm to a few meters away. There is no need for the person being identified to touch any equipment that has recently been touched by a stranger, thereby eliminating an objection that has been raised in some cultures against fingerprint scanners, where a finger has to touch a surface, or retinal scanning, where the eye must be brought very

close to an eyepiece A host of networking associated companies have recently added biometric authentication features to their products. Companies such as Novell, Baltimore Technologies are some of the first to take advantage of biometric scheme. Major applications of iris recognition technology so far have been: substituting for passports, aviation security, and controlling access to restricted areas at airports, database access and computer login; access to buildings and homes, hospital settings, including mother-infant pairing in maternity wards, "watch list" database searching at border crossings, and other Government programmes.

The use of biometrics in networks as an authentication feature is gaining momentum. However the widespread use and acceptance of biometrics is, at this current time, still in its infancy. This paper proposes the reliable and accurate recognition method for iris recognition and also speeding the process.

## 5. Conclusion

In iris recognition, the inner and outer circular templates are not a standard circular shape, using traditional methods cause the problem of pupil legacy and loss of texture. This paper is based on canny edge detection, effectively improves the iris positioning accuracy, through the combination of K-Means algorithm to raise the accuracy and speed of recognition. It guarantees the effective pupil detection to get accurate iris identification.

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