Project Report
on

An Improved Method for Iris Localization for Authentication System

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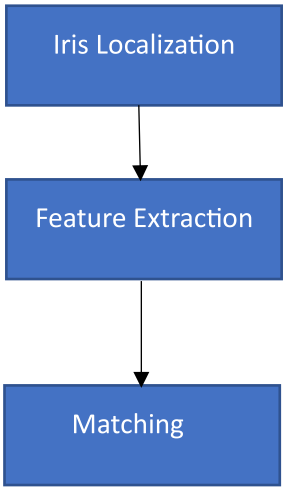
Abstract

This author has presented an improved iris localization method based on wildes and Daugman approaches. The proposed method is faster than Daugman and Wildes has two phases in first phase we check for the Quality of the image and rejects blurred images, incomplete images etc. And then we estimate the center and radius of iris boundaries. After that again we calculate the radius and the center of the iris in the images. The proposed method will take two seconds while the Wildes method takes 8 seconds for iris localization.

Introduction

The Iris Recognition system is a popular biometric authentication technique. It is reliable and gives accurate results. In iris recognition, the most important step is iris localization. Accurately localizing of the iris is necessary for correct identification. Iris Recognitionn has following steps as described below. It takes more time to localize the iris. In this, we will see the Daugman and the Wildes method for iris localization.



First Acquired image is pre-processed then the iris boundaries are calculated after that the feature extraction step is done. After extracting the feature the matching id done with stored template database in the system.

There are many method for iris localization like Daugman,W ildes Nassika etc. for feature selection 2D Gabor filter, DCT methods are ther and also for matching we can use hamming distance ,jakard similarity.

Background And Related Work

1.Daugman Method for iris Localization

Daugman introduced an Integrodifferential operator for the circular edge detection operator.The operator is following

$$\max_{(r,x_0,y_0)} \left| G_\sigma(r) * \frac{\partial}{\partial r} \oint_{r,x_0,y_0} \frac{I(x,y)}{2\pi r} \mathrm{d}s \right|,$$

Where I(x , y)- Intensity of an image   The symbol $*$ denotes convolution, and G(r) is a smoothing function such as a Gaussian of scale.,(x0,y0) is center coordinates   r- radius of the circular path

$$G_\sigma(r) = \frac{1}{\sqrt{2\pi}} e^{\frac{-r^2}{2}}$$

Disadvantage of this Method

Sensitive to blur factor.
Noise(Reflections) in the image also reduces the performance because it is based on intensity.

2. Wildes Method for iris Localization

This Method has two steps.
1. Binary Edge map
 Thresholding the magnitude of the image intensity gradient.

Gradient G(x,y)= $\left|\nabla G(x,y) * I(x,y)\right|$ where $\nabla \equiv (\partial/\partial x, \partial/\partial y)$

and G(x, y) is a 2d gaussian filter

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{(x-x_0)^2+(y-y_0)^2}{2\sigma^2}}$$

2. Hough Circle detection.
- If (x_j, y_j) is edge point

H(x_c, y_c, r) = $\sum_{j=1}^{n} h(x_j, y_j, x_c, y_c, r)$

$$h(x_j, y_j, x_c, y_c, r) = \begin{cases} 1, \ if\ g(x_j, y_j, x_c, y_c, r) = 0 \\ 0\ \ .\ otherwise \end{cases}$$

$g(x_j, y_j, x_c, y_c, r)$ = $(x_j - x_c)^2 + (y_j - y_c)^2 - r^2$

Disadvantage of this Method

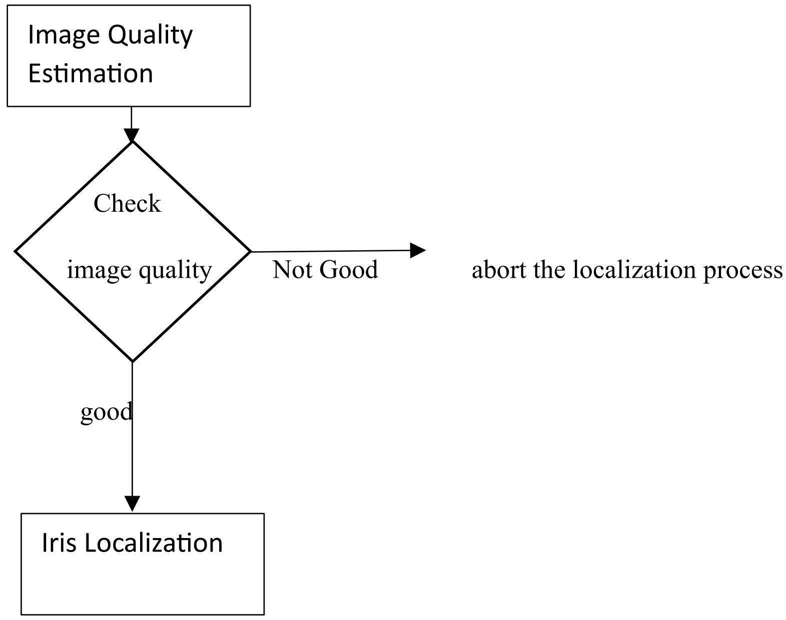
Takes More time

Proposed Method

It is done in two phases.

1. Image quality estimation and Pupil extraction
2. Iris inner and outer circle Localization

Flow Chart of the Proposed Method



Phase 1.

For quality estimation following three parameters should be in a certain range. If for an image these images are in a certain range the image is rejected.

Image Quality Parameters

1. Intensity Evaluation

2. Clarity Evaluation

3. Integrity Evaluation

1. Intensity Evaluation

We calculate the average intensity of the image using the following formulae. And for implementation we have taken an intensity threshold 85.

$$Q_i(I(x,y)) = \frac{1}{m*n}\sum_{x=1}^{m}\sum_{y=1}^{n} I(x,y)$$

2.Clarity Evaluation

The lower the clarity is, the smaller gray difference will be. We use a block-variance method to evaluate image clarity. We divide the whole image into m1*n1 blocks, calculate the variance of pixel gray on each block, let off high-variance blocks and get the mean value of left blocks as the clarity of the image. Threshold for clarity I have taken it as 1.

3.Integrity Evaluation

Integrity of Image - It is defined as the ratio of the number of pupil points and the area of central region.
It is used to evaluate the the complete iris image is in the iris or not.
We calculate integrity of image is two steps

1. Original image is transformed in to binary image by threshold segment method.The first peak of the histogram is right the pupil's gray value to to get the binary image.
2. Valid Pixels as pupil points . Valid points are those pupil's point whose distance to center is d1=0.20

Integrity of image should be greater than 0.25.

$$B(x,y)=\begin{cases}1, (x-\frac{m}{2})^2+(y-\frac{n}{2})^2<(d_1*n)^2 \\ 0, \quad\quad others\end{cases}$$

$$Q_g(I(x,y))=\frac{\sum_{x=1}^{m}\sum_{y=1}^{n}B(x,y)}{m^2*n^2}$$

4.Pupil Region extraction

In the we use the gray value of image to determine the pupil region .

In an eye image pupil,iris,sclera and eyelash have their own gray range.Gray range of the eyelash could overlap pupil's.Using adaptive thresholding for different ranges all the four region is extracted.After we apply erosion and dialation to remove noises.

After that we uses following formulae to extract the final pupil region.

We remove the overlapped area to get final pupil

$$B_{pf}(x,y)=B_p(x,y)\oplus(B_p(x,y)\wedge(B_i(x,y)\vee B_s(x,y)\vee B_e(x,y)))$$

Phase 2

Iris Localization

Circle detection for the pupil and iris is the most consuming part. Following steps are followed.

1. Shrinking Picture
2. Gaussian Filtering
3. Gamma Correction
4. Calculating Gradient
5. Edge Points Detection
6. Regional edge Points value

1.Shrinking Picture

In this, the image is shrunk to minimize the search space to make it faster but to much shrinking can result into incorrect iris estimation. In this paper, the author has taken a 0.6 shrinking ratio for localization.

3.Gaussian Filtering

In this 2-D Gaussian filtering has been used.

$$G(u,v) = \frac{1}{2\pi\sigma^2} e^{\frac{-(u^2+v^2)}{2\sigma^2}}$$

3.Gamma Correction

We normalize the image intensities using this. When gamma correction was on, the color signal was linear in a specific range, not at the lowest or the highest intensities.

4.Calculate Gradient

We have used the finite difference method with first-order partial derivative to calculate the value and direction of the gradient for each pixel. Gradient formula in eight directions works more accurately than that in four directions for being closer to circular shape. The four basic difference factors are

$$\begin{cases} d\alpha(i,j) = I(i+1,j) - I(i-1,j); \\ d\beta(i,j) = I(i,j+1) - i(i,j-1); \\ d\mu(i,j) = I(i+1,j+1) - I(i-1,j-1); \\ d\upsilon(i,j) = I(i-1,j+1) - I(i+1,j-1); \end{cases}$$

dα, dβ, dμ, dv are the differences in vertical, horizon, oblique and anti-oblique directions.

$$\begin{cases} G(x,y) = dx * i + dy * j; \\ dx(i,j) = d\alpha(i,j) + (d\mu(i,j) + d\upsilon(i,j))/2; \\ dy(i,j) = d\beta(i,j) + (d\mu(i,j) - d\upsilon(i,j))/2; \end{cases}$$

$$\arctan(-\frac{dy(i,j)}{dx(i,j)})$$

After that using above formulae we calculate the gradient and direction of the gradient.

5.Edge points detection

First, we compare each pixel to its neighbors to check whether its gradient calculated in previous step is bigger than the neighbors and mark all these points are marked as edge points. Then, we refine the edge points by removing points whose gray are not in expected range. There is a fixed gray range for edge points.

6.Regional edge points vote

For each point in the region estimated in section ċ, suppose (x, y) is the location of center point, r is the radius of pupil circle, and (xi, yi) is the location of edge point, k=1,...,n. now we use vote method as follows

$$V(x,y,r)=\sum_{i=1}^{k} v(x,y,r,x_i,y_i)$$

$$v(x,y,r,x_i,y_i)=\begin{cases} 1, e(x,y,r,x_i,y_i)=0 \\ 0, others \end{cases}$$

$e(x_i, y_i, x, y, r) = (x - x_i)^2 + (y - y_i)^2 - r^2$

Iris Outer Circle Estimation

The center of outer circle is near the center of inner circle and the radius of outer circle is also in proportion to the inner one. r0 is radius of the outer circle, while ri is the inner one.

$$1.8 \le \frac{r_o}{r_i} \le 4.0$$

Since the iris inner circle is found out in previous section, we now come to the scale of center location and radius of outer circle. Similar to iris inner circle localization process (section 4.6), we detect the edge and vote.

Experimental Result

We have used CASIA data set for iris detection.

Phase 1. Image Quality and Pupil Extraction

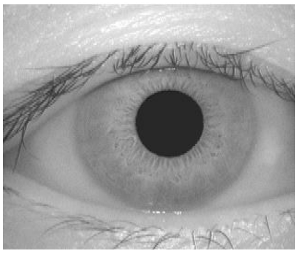
I have taken the following gray value range for pupil extraction.

pupil_range = [0, 50]

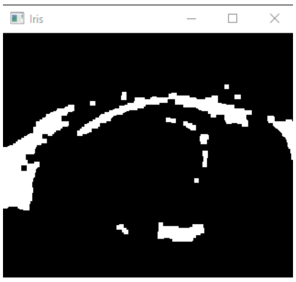
iris_range = [45, 130]

sclera_range = [80, 150]

eyelash_range = [150, 255]

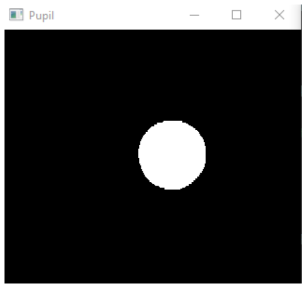


Image

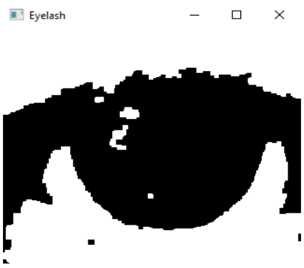


1(a) Iris Region

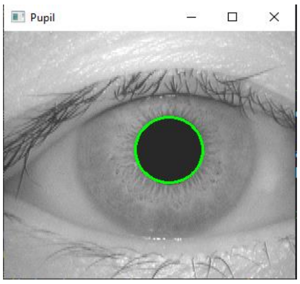
1(b) Sclera Region



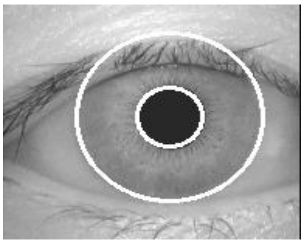
1(c) Pupil Region



1(d) Eyelash Region



1(e) Pupil Extraction



1(f) Iris Localization

Shrinking Factor	**Accuracy(%)**	**Time taken(seconds)**
0.5	**88.805**	**0.854**
0.6	**91.791**	**1.026**
0.7	**97.014**	**1.251**
0.8	**96.268**	**1.577**
1	**97.0149**	**2.130**

The time taken for region extraction for Daugman Method is 8.12 seconds.

The time taken for localization of the iris using proposed method is 1.043 seconds.

Acuracy of iris Localization is 97.014% for scaling factor 0.7

Conclusion

1. In this author has proposed an improved iris localization method for iris detection which minimizes the time taken in comparison to Daugman and Wildes Method.
2. Iris Localization is the most important step in iris recognition.
3. Image quality should be good for correct iris localization.
4. Shrinking the image size reduces the iris localization time.

References

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