Iris Recognition Based on Gabor Filter Using Support Vector Machine

Pooja Meshram
Dept of Embedded and VLSI
Zeal College of Engineering and Research, Pune

Abstract- *The iris recognition is the most reliable and an exact biometric identification system. The Iris recognition system captures an image of an individual's eye. The captured iris image is used for segmentation, normalization and for feature extraction. The performance of the iris recognition system depends on the process of segmentation. The segmentation is used for localization of the correct iris regions from the eye and it should be done correctly and accurately to remove the eyelashes, eyelids, reflection and pupil noises present in the iris region. Daughman's algorithm is used for segmentation of the Iris Recognition. The Iris images are selected from the IITD Database, iris and pupil boundary is detected by using Daughman's algorithm. The segmented iris region will be normalized to minimize the dimensional inconsistencies between the iris regions by using Daughman's Rubber Sheet Model. Features of the iris encoded by using Gabor filter. Multiple classification algorithms are used to calculate how many bits disagreed between the templates of the iris and their results are compared to get the best performance.*

Keywords- Iris, Segmentation, Normalization, Feature Extraction, Matching, Database, Gabor filter, Daughman's algorithm.

I. INTRODUCTION

Biometrics word formed by the combination of Bio (means life) and Metrics (means system used for measurement). Biometrics is a method of analyzing and measuring physical or biological characteristics of the human body for the identification and verification of a person. Biometric System is an automated method for recognizing and verifying the identity of a living person on the basis of some physiological features (retina, face, fingerprint, print, palm, iris) as well as behavioral features (keystroke, signature, voice). Biometric system based on physiological characteristics and behavioral features, some common biometric methods are: Face recognition, Fingerprint, voice recognition, Hand geometry, iris recognition, etc. but the iris recognition is the most reliable method as compared to all other methods due to its advantages such as reliability, stability.

The biometric method consists of the two important processes verification and identification. Verification involves one-to-one match, i.e. matching between captured biometric and specific ID, stored in the database, whereas identification involves one-to-many match, i.e. matching among captured biometric and many known ID.

Amol D. Rahulkar [1] developed directional and rotational filter bank to extract features of an iris to get accurate results.

Vatsa et al. [2] derived two types of distinct the iris feature vectors (Log-Gabor and Euler numbers) from the normalized iris image and fused the match scores using a neural network (support vector machine) to improve the performance. Zhenan Sun, [3] used Ordinal measures to extract the iris features.

Lim et al. [4] used 2-D Haar WT to decompose an iris image into four levels and presented competitive learning neural network (learning vector quantization-LVQ) to improve the efficiency and accuracy. Ma et al. [5] extracted the texture features of the iris using a bank of spatial filters and used a quality descriptor, bootstrap learning method and Fisher linear discriminant to improve the recognition rate. Nabti et al. [6] presented multi-resolution iris feature extraction technique by analysing the iris using first wavelet maxima components and then applying a special Gabor filter bank on the normalized iris image to extract all dominant features. Velisavljevic [7] Presented iris coding and recognition using directionlets based on 9/7bi-orthogonal wavelet basis. Monro et al. [8] presented feature representation based on the difference of optimized discrete cosine transform (DCT) coefficients of overlapped angular patches of the normalized iris image.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

The Iris recognition system becomes such a popular area of research in recent years makes the uniqueness, stability, as its properties are the most reliable among other biometric methods. Iris is a colored part of the human eye which lies between the white sclera and the dark black pupil. Iris is circular in shape, present in front of the eye lens and the cornea. Iris is a colored ring of tissue around the pupil through which light enters the interior of the eye. It controls the light entering the eye through the pupil, by contracting or expanding the diameter of the pupil. Iris sphincter and Dilator muscles are responsible for adjusting the size of the pupil.

Even if iris is an internal part of the body, it is easily visible. Iris gets completely developed when the human is at the age of eight months and it does not change the whole life. The diameter of an iris is about 10% to 80% more than that of the pupil. Iris is the unique part of our body. No two persons in this world can ever have the same iris pattern. Every person has unique iris pattern even the two eyes of the same person have different iris pattern. Not even the twins can have the same iris pattern. This is the reason for using an iris pattern for verifying and identifying a person. The demand for the automatic identification of the person is increasing day by day, gave rise to the biometric accuracy. In an iris recognition system, the color of the eye is not important than a ring, cilia, crypts, connective tissues and corona are used to identify the individual. These are the features that distinguish the human iris. Fig.1 shows the human eye, which shows the location of the iris.

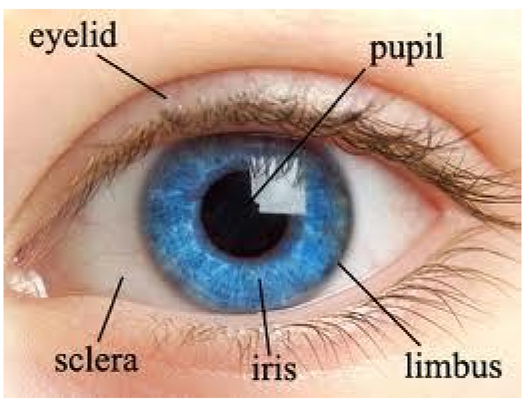


Fig.1 Human eye.

A. IRIS RECOGNITION

Iris recognition is the process of recognizing an individual by analyzing the random pattern of iris and comparing it with that of reference in the database (DB). Iris is an annular part between the pupil (black part) and sclera (white part) of the eye image. The generalized block diagram of iris recognition system is shown in Fig.2. The system is divided into enrollment and authentication modules. The enrollment process consists of iris acquisition, segmentation, normalization and extraction of features from the iris image. These features stored in the database for reference. During the recognition (decision) process, the test iris feature is compared with stored features.

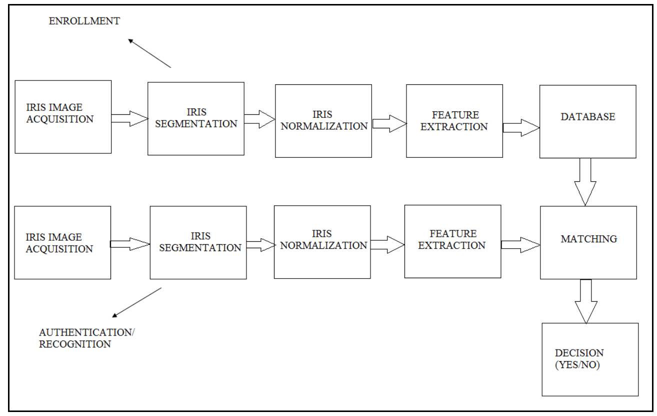


Fig.2 Generalized block diagram of iris recognition system

a. Image Acquisition

The IIT Delhi Iris Database is used in this project which mainly consists of the iris images collected from the students and staff at IIT Delhi, New Delhi, India. The database of 1120 images is organized into 224 different folders each associated with the integer identification/number. The resolution of these images are 320*240 pixels and all these images were acquired in an indoor environment.

b. Iris Segmentation

Iris segmentation is the heart of this process, all remaining steps are depending on this major stage. The main aim of segmentation stage is to localize the two boundaries, the inner boundary of iris and pupil and the outer boundary of iris and sclera. As it could be seen from this figure, segmentation stage includes steps as follows:

1. Localization of iris inner boundary (the boundary between pupil and the iris).
2. Localization of iris outer boundary (the limbic border between sclera and the iris).

1. Iris inner boundary localization

Illumination intensity is very different in pupillary inner and outer parts, and pupil is darker compared with an iris. Integrodifferential operator is used to get centre and radius of iris circle.

2. Iris outer boundary localization

The major and challenging job of segmentation is to find the boundary of iris and sclera because illumination intensity of these two regions is almost same.

Integrodifferential operator is applied to the iris image which scans this illumination difference
An approach used for segmentation: -

Integrodifferential operator

Integrodifferential operator is used for segmenting the circular iris and pupil regions. Integrodifferential operator is defined as,

$$J(r, x0, y0) = G\sigma(r) * (\frac{d}{dr}) \oint \frac{I(x,y)}{2\pi r} ds$$

Where I (x, y) is an input image, r is a radius to search for, $G\sigma(r)$ is a Gaussian smoothing function, contour of the circle given by r, x0, y0. The operator searches for the circular path, where there is a maximum change in pixel values by varying the radius r and the centre (x, y) of the circular contour. The operator is applied iteratively with the amount of smoothing has progressively reduced, to get an accurate localization.

Procedure:

- The operator finds the maximum pixel intensity value change (J) by searching the image within the defined radius parameters with a circular integral cantered on the point (x0, y0) with radius r of the radial derivates of the original image blurred with a Gaussian Kernel G.
- J, in this case, corresponds to the iris-sclera (white) boundary for the pixel intensity change.
- The pupil boundary is then found within the iris-pupil boundary; pupil boundary corresponds to the second largest value of J.

$$J(r, x0, y0) = G\sigma(r) * (\frac{d}{dr}) \oint \frac{I(x,y)}{2\pi r} ds$$

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

c. Normalization

Pupil size gets change as illumination intensity varies. When the illumination intensity of light is more, pupil gets extracted and when the intensity of light is less, pupil gets dilated; to avoid this improper size and to get the proper and fixed size of pupil Daughman's rubber sheet model is used. It converts polar coordinates to Cartesian coordinates. Initially, in polar form, image coordinates were within 0< θ< 360 limits so by converting that into Cartesian 0< r <1, we will get fixed size rectangular strip. Even if pupil size vary rectangular strip will increase linearly.

Figure 3 shows the normalized iris image.

Normalization has three advantages

- It reports the variations in pupil size due to change in illumination intensity.
- It gives you fixed size image by mapping polar coordinates to Cartesian.
- It allows to do the iris registration during matching stage also by simply translating that image.

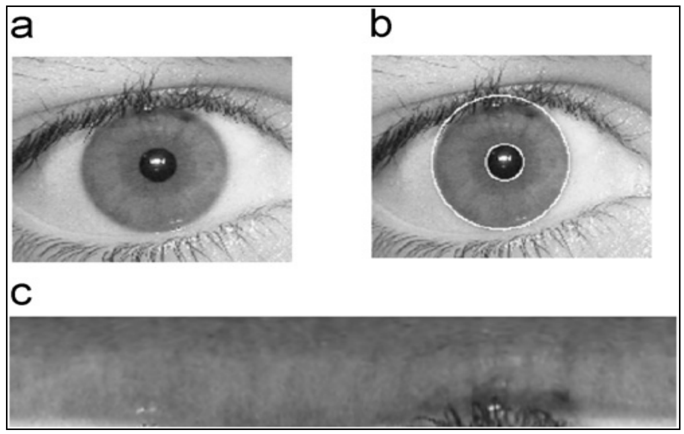


Fig.3 Image after Normalization

Equations:

$$I(X(r,\theta), Y(r,\theta) = I(r,\theta)$$
$$X(r,\theta) = (1-r) * Xp(\theta) + (1-r) * Xi(\theta)$$
$$Y(r,\theta) = (1-r) * Yp(\theta) + (1-r) * Yi(\theta)$$

Above equations are of the Daughman's rubber sheet model.

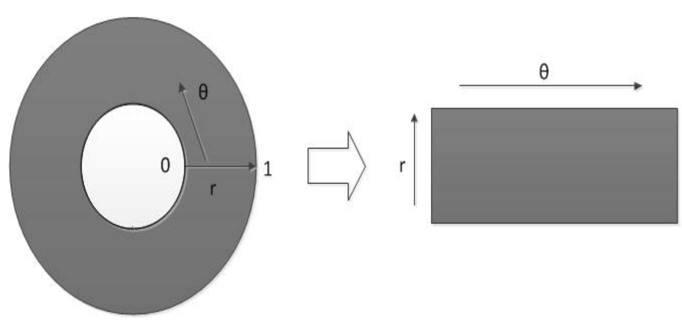


Fig.4 Daughman's rubber sheet model

d. Feature Extraction

In image processing, a Gabor filter is also called as Dennis Gabor, is a linear filter used for edge detection.

Orientation and frequency representations of Gabor filters are similar to those of the human visual system and they have been found appropriate for texture representation and discrimination. In the spatial domain, a 2D Gabor filter is a Gaussian kernel function modulated by a sinusoidal plane wave. Gabor filters with different frequencies and with orientations in different directions have been used to localize and extract text-only regions from complex document images (both gray and color), since the text is rich in high-frequency components, whereas pictures are relatively smooth. Gabor filters are used in texture analysis, edge detection, feature extraction, disparity estimation (in stereo vision). Gabor filters are special classes of bandpass filters, they allow a certain band of frequencies and reject the others.

A Gabor filter responds to edges and texture changes. When we say that a filter responds to a particular feature, we mean that the filter has a distinguishing value at the spatial locations of that feature.

The equation for Gabor filter is as follows:

$$g(x,y;\lambda,\theta,\psi,\sigma,\gamma) = e^{\left(\frac{-x'^2+\gamma^2 y'^2}{2\sigma^2}\right)} e^{\left(i\left(\frac{2\pi x^i}{\lambda}+\psi\right)\right)}$$

e. Matching

SVM is a machine learning algorithm used for classification and is a two-class classifier based on the use of linear discriminant function $g(x) = w^T\mathrm{x} + \mathrm{b}$ which represents hyperplane in the feature space. Support vectors are the data points nearest to the hyperplane. Suppose Class labels are denoted by +1 and -1 and L is a set of labeled training patterns then, $X = \{(xi, yi), 1 \le i \le L\}$, $X \in Rn, Yi \in \{-1, +1\}$ and each Xi is an n-dimensional real vector. The SVM determine the optimal linear discriminant function with help of support vectors and is given by $w^T X + b = 0$ where Yi = 0 for all i.

This is the equation of hyperplane. To find the maximum margin between two classes, two support planes are determined. Positive class support plane (positive gutter) is denoted by $w^T X + b = 1$ which lies in positive class (Yi= +1). Negative class support plane (negative gutter) is denoted by $w^T X + b = -1$ which lies in negative class (Yi_= -1). Here w € Rn represents the normal to the hyperplane and b € R is the offset to y-axis. To maximize the margin, it should minimize $\frac{1}{2}\|W\|^2$ such that, for Yi=+1, $w^T X + b \ge 1$ and for Yi= -1, $w^T X + b \le -1$.

The geometrical representation of the linear discriminant function (hyperplane) and the support planes is shown in below figure.

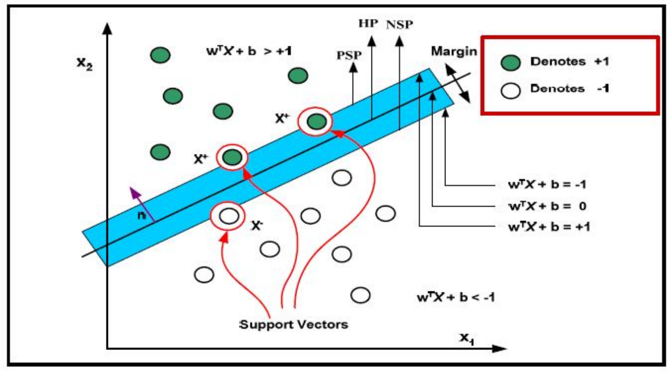
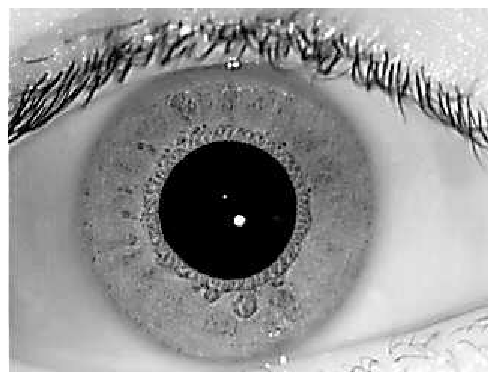


Fig.4 Support vector representation

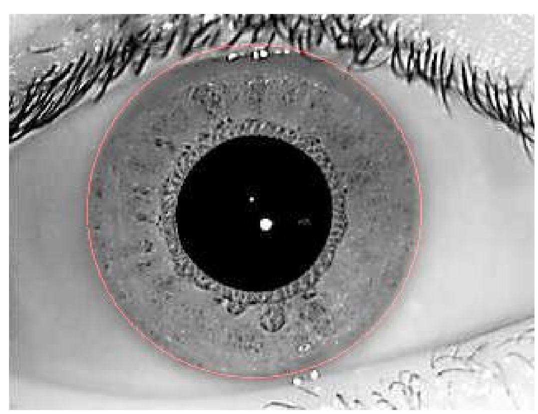
III. RESULTS

1) Input image

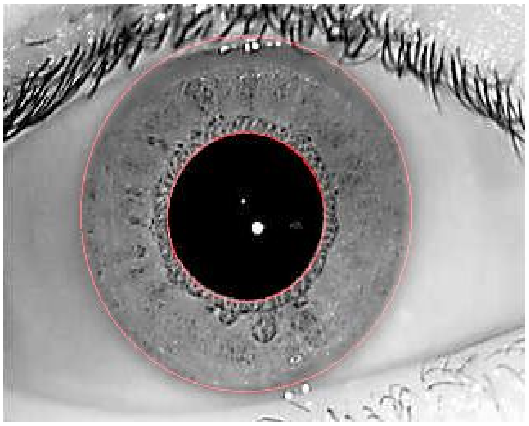


2) Image after segmentation

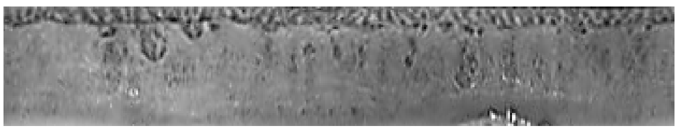
a) Inner Boundary localization



b) Outer Boundary Localization



3) Image after Normalization



Sensitivity:

Sensitivity (called the true positive rate) measures the proportion of positives which are correctly identified. Specificity relates to the test's ability to correctly detect patients without a condition.

$$Sensitivity = \frac{Number\ of\ True\ Positive(TP)}{Number\ of\ True\ Positive(TP)\ + Number\ of\ False\ Negative(FN)}$$

$$Sensitivity = \frac{(TP)}{(TP)+(FN)}$$

Specificity:

Specificity (called the true negative rate) measures the proportion of negatives which are correctly identified. Specificity relates to the test's ability to correctly detect patients without a condition.

$$Specificity = \frac{Number\ of\ True\ Negative(TN)}{Number\ of\ True\ Negative(TN)\ + Number\ of\ False\ Positive(FP)}$$

$$Specificity = \frac{(TN)}{(TN)+(FP)}$$

Calculations

Input Images	TP	FP	FN	TN	Precision	Sensitivity	Specificity
0	3	0	0	90	1	1	1
1	3	0	0	90	1	1	1
2	3	1	0	89	0.75	1	0.99
3	2	0	1	90	1	0.67	1
4	3	2	0	88	0.6	1	0.98
5	2	2	1	86	0.5	0.67	0.98
6	3	4	0	90	0.43	1	0.96
7	3	0	0	90	1	1	1
8	3	0	0	89	1	1	1
9	3	1	0	89	0.75	1	0.99
10	1	1	2	90	0.5	0.33	0.99
11	3	0	0	89	1	1	1
12	3	1	0	90	0.75	1	0.99
13	3	0	0	88	1	1	1
14	2	2	1	90	0.5	0.67	0.98
15	0	0	3	90	0	0	1
16	2	1	1	89	0.67	0.67	0.99
17	0	1	3	89	0	0	0.99
18	0	2	3	88	0	0	0.98
19	2	1	1	89	0.67	0.67	0.99
20	3	0	0	90	1	1	1
21	2	0	1	90	1	0.67	1
22	3	0	0	90	1	1	1
23	3	2	0	88	0.6	1	0.98
24	2	0	1	90	1	0.67	1
25	2	0	1	90	1	0.67	1
26	3	1	0	89	0.75	1	1.99
27	2	0	1	90	1	0.67	1
28	1	1	2	89	0.5	0.33	0.99
29	3	1	0	89	0.75	1	0.99
30	1	0	2	90	1	0.33	1

Model Accuracy is 80%

VI. CONCLUSION

A person can be identified by a number of ways, but instead of carrying bank of keys or remembering things as passwords we can use us as living password, which is called biometric recognition technology it uses physical characteristics or habits of any person for identification. In biometric, we have a number of characteristics which we are using in our recognition technology as a fingerprint, palm print, signature, face, iris recognition, thumb impression and so on but among these iris recognition is the best technology for identification of a person.

The use of the iris recognition system has been seen in various areas of life, such as airport, crime detection, business application, various research firms, and industries.

REFERENCES

[1] A.D. Rahulkar, D.V. Jadhav, R.S. Holambe, Partial iris feature extraction and recognition based on a new combined directional and rotated directional wavelet filter banks, 1556-6013/$26.00 © 2011 IEEE.

[2] M. Vatsa, R. Singh, A. Noore, improving iris recognition performance using segmentation, quality enhancement, match score fusion, and indexing, IEEE Trans. Syst. Man, Cybern. Part B: Cybern.38 (4) (2008)1021–1034.

[3] Zhenan Sun, Ordinal Measures for Iris Recognition, IEEE transactions on pattern analysis and machine intelligence, vol. 31, no. 12, Dec 2009.

[4] S. Lim, K. Lee, O. Byeon, T. Kim, Efficient iris recognition through improvement of feature vector and classifier, ETRI J. 23 (2) (2001) 61–70.

[5] L. Ma, T. Tan, Y. Wang, D. Zhang, Personal identification based on iris texture analysis, IEEE Trans. Pattern Anal. Mach. Intell. 25 (12) (2003) 1519–1533.

[6] M. Nabti, L. Ghouti, A. Bouridane, an effective and fast iris recognition system based on a combined multiscale feature extraction technique, Pattern Recognition 41(2008) 868–879.

[7] V. Velisavljevic, Low Complexity iris coding and recognition based on directionlets. IEEE Trans. Inf. Forensics Secure 4 (3) (2009) 410–417.

[8] D.M. Monro, S. Rakshit, D. Zhang, DCT based iris recognition, IEEE Trans. Pattern Anal. Mach. Intell. 29 (4) (2007) 586–594.