Blood Vessel Segmentation for IRIS in Unconstrained Environments using Moment Method

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Abstract

In recent years the use of smart technology is increasing day by day and also to provide security to such devices biometric identification and recognition plays an important role. In biometric identification the one most efficient and reliable technique is found to Iris Recognition (IR). Previous iris recognition system (IRS) is restricted to focused on images acquired in limited environments likewise in laboratory for research. But, with the adaption of technology the scenario is changed. In this research, proposed Iris recognition using blood vessel segmentation (bvs). In preprocessing process, the iris image is improved using Adaptive Median Filter (AMF). After the bvs process, the segmented iris image is recognized using moment features. For feature extraction process the technique used is Standard Deviation (SD), Kurtosis, Skewness, Smoothness, Variance and Root Mean Square (RMS). For training process, extracted features are classified using well known Support Vector Machine (SVM) classifier. The performance of proposed work is evaluated using High Resolution Fundus (HRF) Image Database. The performance of proposed features is better as compared to previous work. The proposed IR approach is more secure and robust against blood vessel segmentation and has the ability to identify retinal images from the iris photograph images. Also the proposed result is more efficient in terms of accuracy as well as time complexity.

Keywords - *Biometric recognition; Iris Recognition; Iris segmentation; Accuracy; Adaptive Median Filter; Blood Vessel.*

I. INTRODUCTION

For assurance of public security, various biometrics security techniques have been proposed such as face, iris, hand geometry etc. Among the all available biometrics recognition techniques, IR is proved to be the most reliable and efficient technique [1]. IR is a biometric recognition method that uses pattern recognition to identify and verify the images of iris [2]. The use of IRS is regularly increasing in various areas for security and access control in border areas etc. and due to its unique features like a furrow, rings, ridges, complex patterns and freckles [3]. The main advantage of IR is speed for matching and gives accurate result in false matches related to iris and also protects not only internal but externally visible eye organ [4].

Theproposed system consists of five stages. The main objective is recognition of iris samples. The first step is data collection procedure where iris image samples are taken for further processing and data measurements. Second phase of this experimental study is to pre-process the iris image samples for a standard benchmark and most importantly removal of noises to obtain the enhanced noise free images. Third and one of the most important phases is blood vessel segmentation. Then fourth one is feature extraction. Here in this phase color, shape and texture based features from the enhanced images are extracted by computing. The well-known SVM classifier is trained using these features which are then further used for IR.

II. LITERATURE REVIEW

AbduljalilRadman et al. [5] proposed a model using Histograms of Oriented Gradients descriptor and SVM (HOG-SVM). Using this localization method, iris texture is extracted automatically by Grow-Cut technique by means of cellular automata. Preprocessing and post-processing operations are done to guarantee higher segmentation accuracy.
In view of this restriction, iris surface is consequently removed by methods for cell automata which developed by means of the GrowCut strategy. Pre- and post-handling activities are additionally acquainted with guarantee higher division exactness. Broad test comes about show the adequacy of this strategy on unconstrained iris images. It is all the more encouraging recognizing iris area in view of noise impacts.

Tossy Thomas et al. [6] presented a more precise method called RANSAC (Random Sample Consensus) for fitting ellipse around non circular iris boundaries. The method can locate more accurate iris boundaries over Hough transform method. For iris normalization & elliptic unwrapping, use of Daugman’s rubber sheet model. And for template matching the similarity measure used is correlation based filter for matching the distance between inter and intra class distance. With such method the recognition process is improved as compared to Daugman's method as applied on limited database.

Naglaa F.Soliman et al. [7] presented that the iris gray image is transformed to a binary image using an adaptive threshold obtained from analyzing the image intensity histogram. Morphological handling is then used to separate an underlying focus point, which is considered as the underlying place for both pupil and iris limits. At last, a refinement step is made utilizing an integro-differential administrator to get the last iris and pupil focuses and radii. This framework turns out to be vigorous against impediments and power varieties. In a few images, limitation did not find appropriately.

Aparna G. Gale et al. [8] presented the Haar transform and block sum algorithm for feature extraction process. The classifiers used in this study are hybrid classifier i.e. ANN and FAR/ FRR and the experimental results show that this technique produces good performance on CASIA VI iris database.

III. PROBLEM DEFINITION

When there is bas lighting or occlusion by eyelids as well as noise, the performance of the system degrades. When there is a noise, it cannot perform well. Detected edges are not sharp. The experimental results did not achieve good accuracy. One of the important but often ignored factors is pupil dilation. Due to dilation effects, we have varying size of pupil, which results in decreased recognition performance. Dilation may occur due to many factors such as drugs, sunglasses, light illumination, etc.

IV. PROPOSED WORK

In this proposed work, first of all take iris image then apply preprocessing steps (resizing, enhancement), after that segment the enhanced image using blood vessel segmentation. Finally, normalize the detected image. Then we will extract shape and texture feature. Determine the similarity matrix of query image and image database using Euclidean distance (ED), Hamming distance (HD) and Spearmen distance (SD).

In this use of ED, under below equations. Moreover, methods used to arrange the images and evaluate the difference between two vectors. We have used Euclidean distance which is the most predictable metric for calculating the lack of involvement between two vectors. Find the distance using ED. Given two vectors *T* and D, where

$$d(T, D) = \sum_m \sum_n d_{mn}\,(T, D)$$

Where

$$d_{mn} = \frac{|(\mu_{mn}^T - \mu_{mn}^D)|}{|\mu_{mn}^T| + |\mu_{mn}^D|} + \frac{|(\mu_{mn}^T - \mu_{mn}^D)|}{|\mu_{mn}^T| + |\mu_{mn}^D|}$$

The fig 1 shows the basic block diagram functionality of IRS:

A. *Image acquisition*

In the initial stage of IRS is capturing an image from iris. And the image acquisition stage is much necessary for success of other recognition stages due to quality of images capture from iris [9]. In some images, if the visible light is used as amid imaging for those individuals whose iris is dim, a slight difference comes to presence amongst iris and pupil which makes it difficult to isolate these two regions in later stage.

B. *Pre-processing*

To improve and simplify the later stage processing, a primary processing is performed on iris images. The preprocessing of iris image is the combination of image localization & normalization [10]. In this stage of preprocessing, to improve the iris image using AMF method for removing noise effect from an image.

Adaptive Median Filter-

AMF performs spatial preparing to figure out which pixels in an image have been influenced by impulse noise. It groups pixels as noise by contrasting every pixel in the image e with its encompassing neighbor pixels. The extent of the area is customizable, and in addition the edge for the correlation. A pixel that is unique in relation to a dominant part of its neighbors, and additionally being not basically lined up with those pixels to which it is comparable, is named as motivation clamor. These noise pixels are then supplanted by the middle pixel estimation of the pixels in the area that have breezed through the clamor marking test [11].

C. *Iris Segmentation*

In this stage of iris segmentation, extracting the features that gives information related to iris pattern [12]. The basic idea behind is to remove unnecessary information of pupil segment and the outside part is iris (eyelids, sclera, skin). The progress of segmentation depends on the image quality of eye images.

In this step the boundary region of iris is identified and after that converts this segmented region into template in the normalization step [13]. The major reason for most IRS failure is inaccurate segmentation.

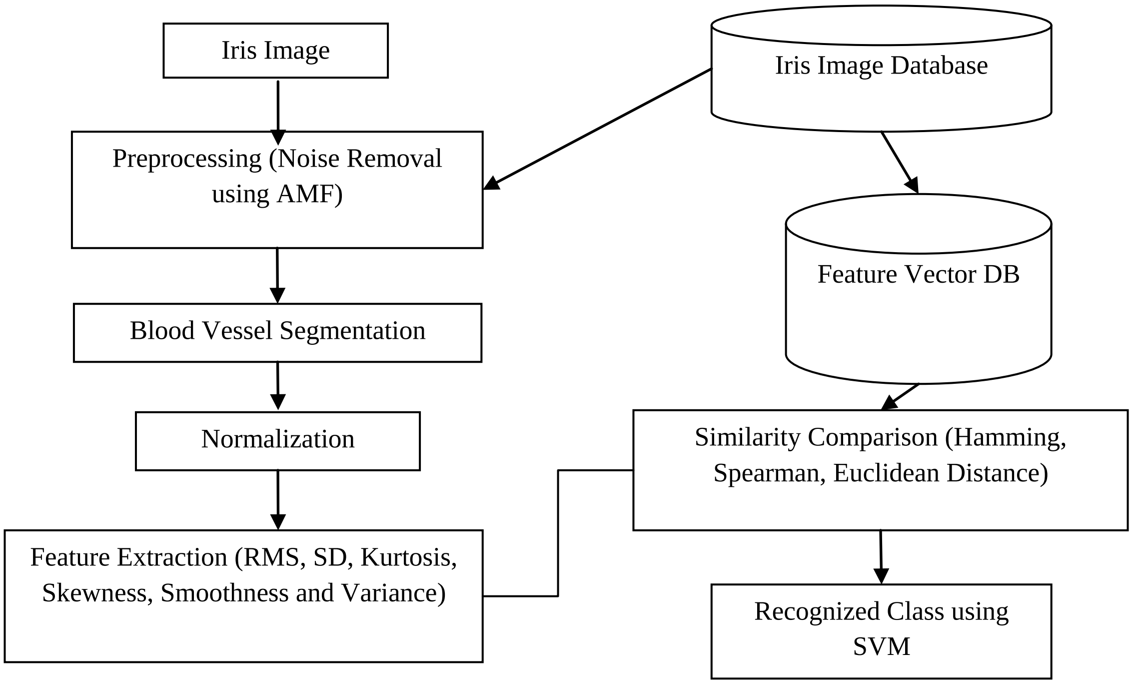

Fig. 1. Block Diagram of IR

D. Normalization

In this stage of IRS, capture the iris of different person in different size and even for same eye the size may change due to illumination and other factors. The normalization will make iris regions, which have the same unvarying extents, with the goal that two photos of the same iris under divergent circumstance will have Characteristic highlights at the same spatial area [14].

E. Feature Extraction

In this stage of IRS, the important features of iris must be encoded so that process of comparisons between templates ends [14]. In this step, extract features of iris using SD, Kurtosis, RMS, Skewness, Smoothness and Variance. And store the feature vector in .mat file.

1. Variance

It quantifies how far an arrangement of (irregular) numbers is spread out from their normal value. The difference is the square of the SD, the second focal snapshot of an appropriation, and the covariance of the irregular variable with itself [15].

2. SD

It calculates that is utilized to evaluate the measure of variety or scattering of an arrangement of information esteems. A low SD shows that the information guides incline toward be near the mean (likewise called the normal value) of the set, while a high SD demonstrates that the information brings up spread out finished a more extensive scope of qualities [16].

3. Skewness

It characterized as the asymmetry of the likelihood dispersion of a genuine esteemed arbitrary variable about its mean. It esteems can be certain or negative, or indistinct [17].

4. Kurtosis

It is a descriptor of the shape of a likelihood circulation and, similarly with respect to skewness. The example kurtosis is a valuable measure of whether there is an issue with anomalies in an informational index. Bigger kurtosis demonstrates a more genuine exception issue, and may lead the researcher to choose alternative statistical methods [18].

5. RMS

It is characterized as the square root of the mean square. It estimated the imperfection of the estimator to the information [19].

6. Smoothness

It is a property estimated by the number of derivatives that are persistent [20].

i) Matching

In this stage~~,~~ identification, one with many pattern; or verification, one with another pattern; compared and matched with iris code being saved in database [21].

Using hamming distance, spearman and Euclidean distance, compare two images on the basis of nearest distance. After that, it classifies the data using SVM.

SVM-Once the features have been extracted, these extracted features are then used for iris classification using SVM. It also known as Kernel Machines is a well-known and most accurate set of algorithms. It is similar to Bayes classifier[22] in many ways. It is comparatively difficult to train and slow to evaluate. But it is more accurate. If we increase the dimensionality of the data, it is very easy to separate the data. The N dimensional space is used by SVM where N is the number of samples in the training set. Due to this, it is able to classify data with arbitrary complexity. But the major drawback of this method is outliers. They are responsible for sabotaging the classifier easily [23].

Steps of Proposed System

1. Consider an iris input image I_n and resize the image with 584×565 resolution.
2. Change the RGB to gray image for fast processing and represented as I_{gray} .
3. Improve image contrast usingCLAHE [24] and it is denoted by I_{CLAHE}.
4. Background Exclusion by using Average Filter. It is denoted as I_{avg}
5. Take the I_{diff} difference between the gray image andfiltered Image.

$$I_{diff} = I_{gray} - I_{avg}$$

6. Threshold the image using the IsoData Method [25].
7. Convert to Binary and it represented as I_{bin}
8. Remove small pixels by using morphologicalopen operation as $I_{morp\ h}$
9. Overlay the images and represented as I_{seg}
10. Remove noise from I_{seg} using AMF and generateI_{final} .
11. Extract features of final image using below methods:

$$\mu = \frac{1}{N}\sum_{i=1}^{N}\sum_{j=1}^{N} I_{final\ i,j}$$

Where I_{final} is final image, $i$and j is number of rows and column

a. Extract color features of I_{final} with the help of RMS:

$$RMS = mean2\left(\sqrt{\frac{1}{N}\sum_{i=1}^{N}\sum_{j=1}^{N} I_{final\ i,j}}\right)$$

In this step, put high weights on the elements which was differ from the average sum of value of P(i, j) image, for k = 0, 1,...,G − 1. G indicates the number of gray intensities; μ represents the mean value of P.

$$\text{VARIANCE} = \sum_{i=0}^{G-1}\sum_{j=0}^{G-1}(P(i,j)-\mu)^2$$

b. Calculate the second moment (standard deviation) for color feature using below formula:

$$STD = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\sum_{j=1}^{N} a}$$

Where a=$\left(I_{final\ i,j} - M\right)^2$

c. Find smoothness of the segmented image for texture feature.

d. Find the degree of asymmetry of an image and is known as third moment (Skewness).

$$Skewness = \sqrt[3]{\frac{1}{N}\sum_{i=1}^{N}\sum_{j=1}^{N} a}$$

Where a=$\left(I_{final\ i,j} - M\right)^3$

e. Kurtosis is measured for a fourth moment of an image.

$$Kurtosis = \sqrt[4]{\frac{1}{N}\sum_{i=1}^{N}\sum_{j=1}^{N} a}$$

Where a=$\left(I_{final\ i,j} - M\right)^4$

12. Store all features of final image in the.mat file for classification process. Classify the data using SVM process and it predicts the class.

V. PERFORMANCE MEASUREMENT

In this section discuss about performance parameter of iris recognition system and also shows iris image comparison on different enhancement methods as well. This algorithm implemented on MATLAB software using Image Processing Toolbox. In this approach, we have taken HRF database for iris segmentation.

High Resolution Fundus (HRF) Image Database: This database has been set up by a cooperative research gathering to help near examinations on programmed division calculations on retinal fundus pictures. The public database contains at the moment 15 images of healthy patients, 15 images of patients with diabetic retinopathy and 15 images of glaucomatous patients [14].

Accuracy- Calculate Accuracy of the system using below formula:

$$\text{ACC} = 100 \times ((\text{TP} + \text{TN})/\text{N})$$

Where ACC represents accuracy, TP denoted true positive and TN denoted true negative, and N is size of dataset

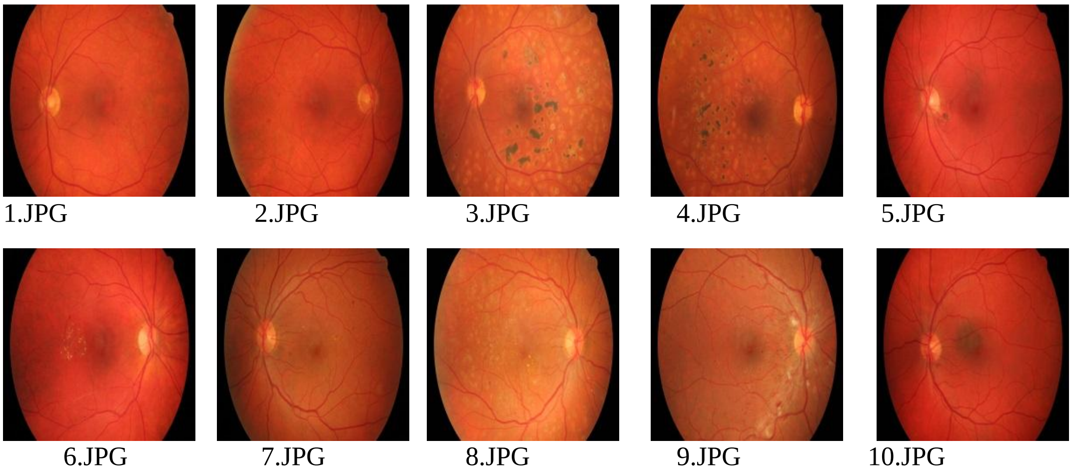

Fig. 2. HRF Dataset

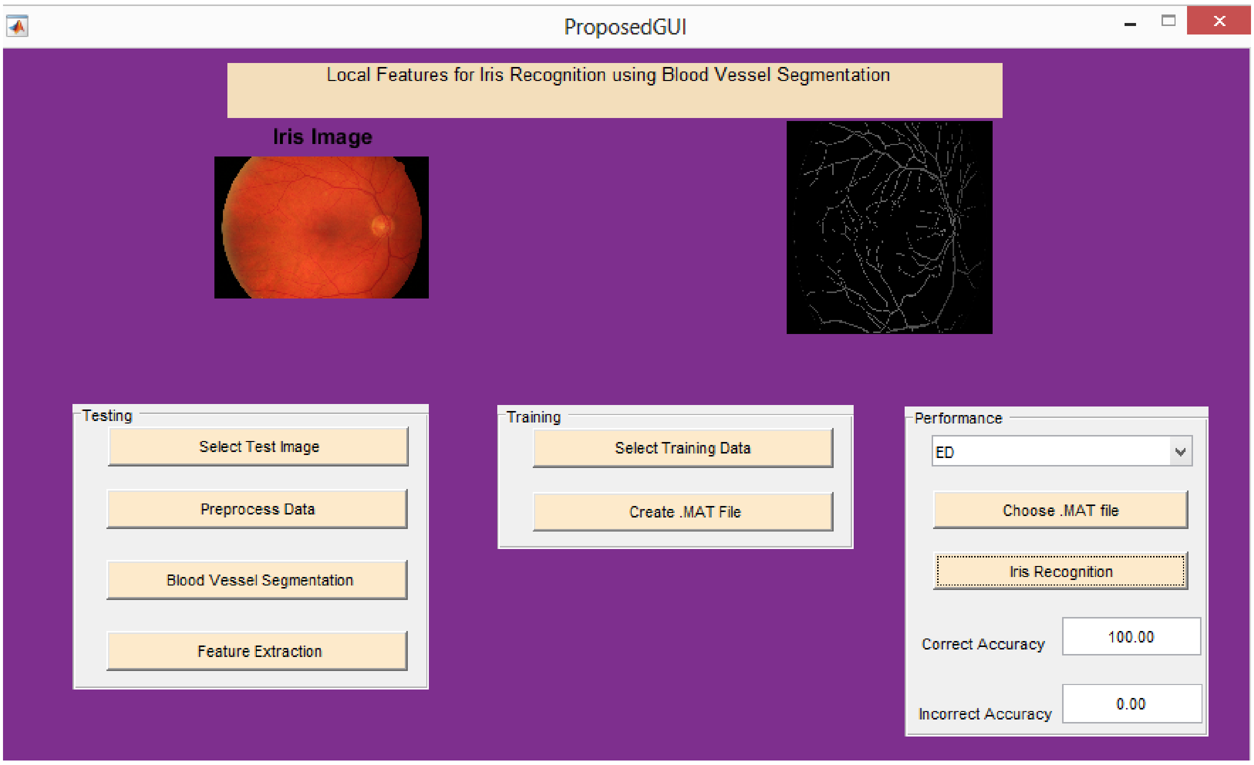

Fig. 3. GUI of Proposed System

TABLE I. COMPARISON RESULT IS CALCULATED BETWEEN PROPOSED SYSTEM AND DIFFERENT METHOD FOR HRF DATASET

Images	Gabor Correct ACC (%)	GLCM Correct ACC (%)	GLCM+GABOR Correct ACC [10] (%)	Proposed Correct ACC (%)
1.JPG	66.67	44.44	61.11	89.47
2.JPG	38.88	44.44	55.56	100
3.JPG	44.44	55.56	66.67	89.47
4.JPG	50.00	38.89	61.11	89.47
5.JPG	50.00	55.56	50.00	89.47
6.JPG	33.33	55.56	55.56	94.74
7.JPG	66.67	50.00	55.56	84.21
8.JPG	38.88	38.89	61.11	89.47
9.JPG	50.00	33.33	55.56	89.47

10.JPG	55.56	27.78	50.00	89.47
Average	49.44	44.44	88.33	90.5

By using proposed method, the accuracy rate of correct classification is 90.5% as compared to other methods it gives better performance. The table shows the accuracy rate shown in Table 1.

TABLE II. COMPARISON RESULT IS CALCULATED BETWEEN PROPOSED SYSTEM AND DIFFERENT METHOD FOR HRF DATASET

Images	Gabor Incorrect ACC (%)	GLCM Incorrect ACC (%)	GLCM+GABOR Incorrect ACC (%)	Proposed Incorrect ACC (%)
1.JPG	33.33	55.56	38.89	10.53
2.JPG	61.11	55.56	44.44	0.00
3.JPG	55.56	44.44	33.33	10.53
4.JPG	50.00	61.11	38.89	10.53
5.JPG	50.00	44.44	50.00	10.53
6.JPG	66.67	44.44	44.44	5.26
7.JPG	33.33	50.00	44.44	15.79
8.JPG	61.11	61.11	38.89	10.53
9.JPG	50.00	66.67	44.44	10.53
10.JPG	44.44	72.22	50.00	10.53
Average	50.55	55.55	11.66	9.47

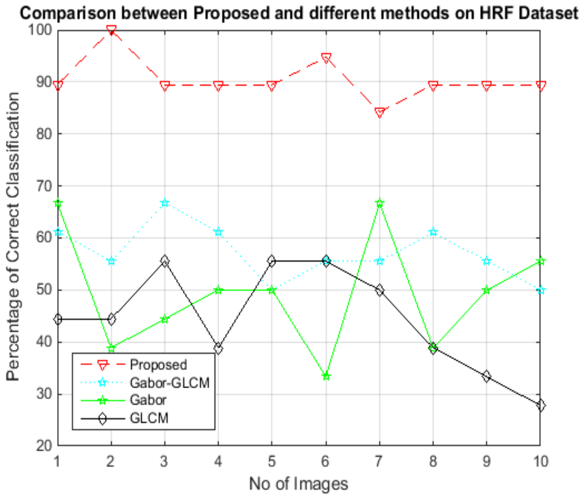

Fig. 4. Shows Correct Accuracy Comparison between Proposed and different methods

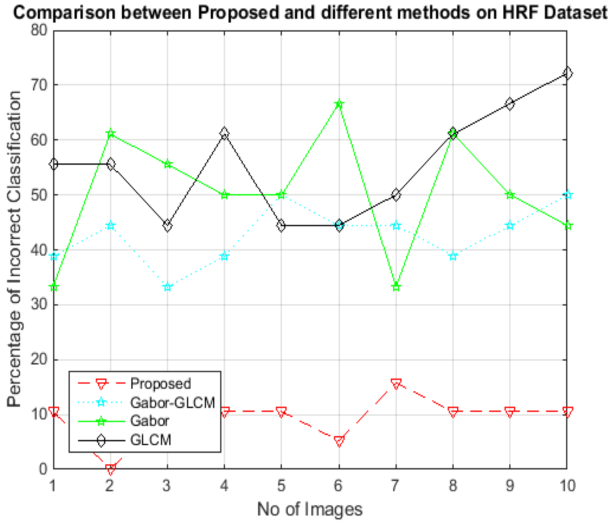

Fig. 5. Shows Incorrect Accuracy Comparison between Proposed and different methods

By using proposed method, the accuracy rate of incorrect classification is decreased up to 9.47% as compared to other methods it gives better performance. The graph shows the incorrect accuracy rate shown in Fig 5.

VI. CONCLUSION

In this paper, new method for iris pictures obtained in unconstrained conditions has been introduced. This technique enhances the unconstrained iris division process in two different ways. In the first place, it diminishes false division comes about utilizing limiting the iris structure in light of the proposed SVM technique. This significantly contributes to mitigation of the segmentation in non-iris regions. Second, it extracts iris features from surrounding structures using the local technique (Standard deviation, Kurtosis, RMS, Skewness, Smoothness and Variance). For classification, we have used SVM classifier. For the performance evaluation of HRF standard image dataset, iris recognition process is carried out by using blood vessel segmentation.

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