International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 8 Aug. 2022, pp: 1111-1120 www.ijaem.net ISSN: 2395-5252

Literature Review and Technical Overview on Iris Recognition System

Mrs. Jamuna K M
Assistant Professor, Department of Computer Science,
The Yenepoya Institute of Arts, Science, Commerce and Management,
(Yenepoya, Deemed to be University)
Mangalore, Karnataka-575002

Submitted: 10-08-2022 Revised: 20-08-2022 Accepted: 22-08-2022

ABSTRACT
Biometrics systems have drawn far-reaching attention in recent times for their operation in different sectors. Automated particular identity authentication systems grounded on iris recognition are considered to be the most dependable among all biometric styles. Due to its high delicacy and oneness, it is used in various fields of access control and for security at border areas. Iris recognition is the method of identifying people based on unique patterns within the ring-shaped region surrounding the pupil of the eye. In this paper, we present a timeline technical overview and survey of various iris recognition techniques available in literature starting from Daugman's original work in 1993.

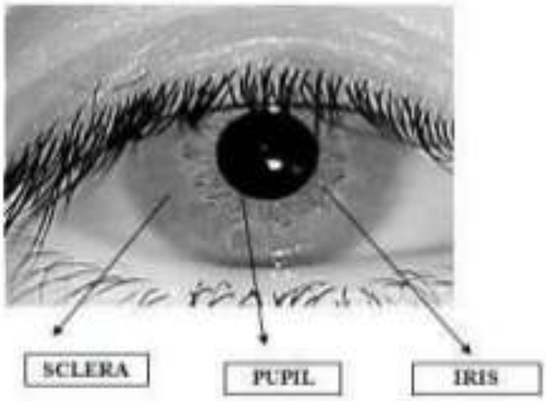
The study of physical attributes or behavioral qualities of humans, for example, fingerprints, face, hand geometry, walk, keystrokes, voice, and iris is termed biometric. Among all the biometrics, the iris is highly precise and constitutes solid attributes. An iris has exceptional structure and stability over a man's lifetime. Iris recognition is an extremely reliable method of biometric authentication using pattern recognition techniques based on high-resolution images of the irises of an individual's eyes. A Typical iris recognition system consists of mainly image capturing, Localization, Segmentation; Feature extraction, and Matching/characterization. The overall performance of the biometric system because of iris recognition depends upon the selection of iris elements. This paper gives a larger picture of the current state of Iris recognition systems, covering right from the type of camera to be used for image capture to the list of algorithms being used for research in iris recognition systems and their performance rate in the form of comparative analysis [1]

Keywords: Biometrics, Iris recognition, Techniques, Localisation, Segmentation, Feature Extraction Matching

I. INTRODUCTION

A Biometric system is an automated method of recognizing a person based on physiological and behavioral traits. Biometric recognition system analyses unique physiological traits or behavioral characteristics for identification or verification. The physiological traits include an iris, face, fingerprint, retina, vein, voice, or hand geometry, while behavioral traits include handwriting, walking gait, signature, and typing keystrokes. Among these traits, iris recognition has been considered to be the most accurate and reliable biometric system. The iris is bounded by the pupil at the inner boundary and the sclera at its outer boundary. Iris is the colored round-shaped internal organ that controls the pupil's size and serves to regulate how much light can penetrate the eye (Dauok et al, 2002). Iris patterns possess a high degree of randomness and uniqueness even between identical twins and remain constantly stable throughout an adult's life (Mohammed et al, 2014). Iris recognition is a method of identifying people based on unique patterns within the ring-shaped region surrounding the pupil of the eye. The uniqueness of the iris patterns comes from the richness of the texture details arising from the crypts, radial furrows, filaments, pigment frills, flecks, stripes, and arching ligaments. These give rise to complex and irregular textures that are so randomly distributed as to make the human iris one of the most reliable biometric characteristics. (Rana et al, 2019) The human iris is one of the most reliable biometrics because of its uniqueness, stability, and non-invasive nature. The iris patterns are unique; no two irises are alike even if they are from identical twins or the left to right eye in the same person. A front outlook of the iris is shown in the below figure.

Iris recognition system is advantageous and applicable in information security and authentication of individuals in different fields such as controlling access to security zones, verification of passengers at airports, and stations, computer access at defense establishments, research company, database access control in distributed systems, etc.



The area of iris recognition technology reveals innumerable methods and algorithms for implementation which basically, include the following strategic steps [2]:

- Localization of eye
- Boundary segmentation of iris and pupil
- Normalization
- Local feature extractions and
- Classification and Matching

The key advantage of iris recognition, in addition to its speed for matching and its extreme resistance to false matches, is the constancy of the iris as, protected, as an internal but externally visible eye organ. Figure 1 illustrates the block diagram for a biometric system for iris recognition in unconstrained environments in which every block's function is briefly given [3]:

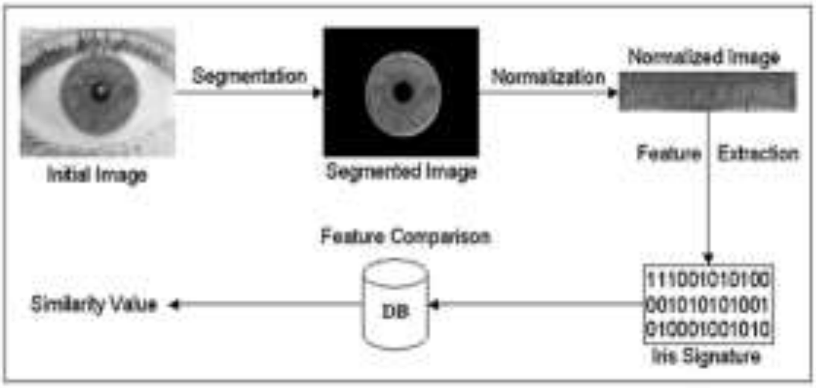


Image acquisition and Localization of the eye: - This stage involves capturing the photo of the iris and preprocessing by contrast adjustment, illumination free, and edge detection with a multiplier.

Boundary Segmentation: This step extracts the object of specific interest by localization of boundary among iris and eyelids and localization of iris inner and outer boundaries.

Normalization: This phase includes the transformation of the segmented iris image from polar to Cartesian coordinates with the normalization of the iris image

Local Feature extraction: The Feature extraction mainly concentrates on generating unique

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 8 Aug. 2022, pp: 1111-1120 www.ijaem.net ISSN: 2395-5252

representation for every iris image of an individual's eye

Classification and matching: This level involves applying all the above stages of iris recognition on the testing iris image resulting in an iris code for comparison with the matching of the iris code being saved in the database.

II. LITERATURE REVIEW

There are several design methodologies for iris recognition system which mainly constitutes [4]:

Phase Base Method: The goal of the phase-based method is to recognize iris patterns revealing phase information, which is free of imaging contrast and illumination. The integral differential operator plays an important role in extracting the object of interest by providing clear-cut boundary isolation between pupil and iris.

Texture-Analysis Based: The silicon intensified target camera coupled with a standard frame grabber and resolution of 512x480 pixels was used to capture High-quality iris images applying The Laplacian of Gaussian (LoG) to the image at multiple scales constructing Laplacian.

Zero Crossing Representation Method: The features of the iris are extracted at different resolution levels based on the wavelet transform zero-crossing. The translation, rotation, and scale-invariant are the key attributes of the algorithms. a set of 1D signals and its zero-crossing representation based on its dyadic wavelet transform, virtual circles are used in the process highly reducing the computation time and data points.

Approach Using Independent Component Analysis(ICA): This method adopts the integrodifferential operator and parabolic curve fitting to extract iris texture features and localization.

Iris Authentication based On Continuous Dynamic Programming: It authenticates the iris based on kinematic characteristics and acceleration. Continuous dynamic programming is used with the concept of comparing shape characteristics part-wise.

Approach Based on Intensity Variations: It uses the Canny edge detection operator, Hough transform and Gabor Filters to acquire frequency band in the spatial domain

IMAGE ACQUISITION AND LOCALIZATION OF EYE

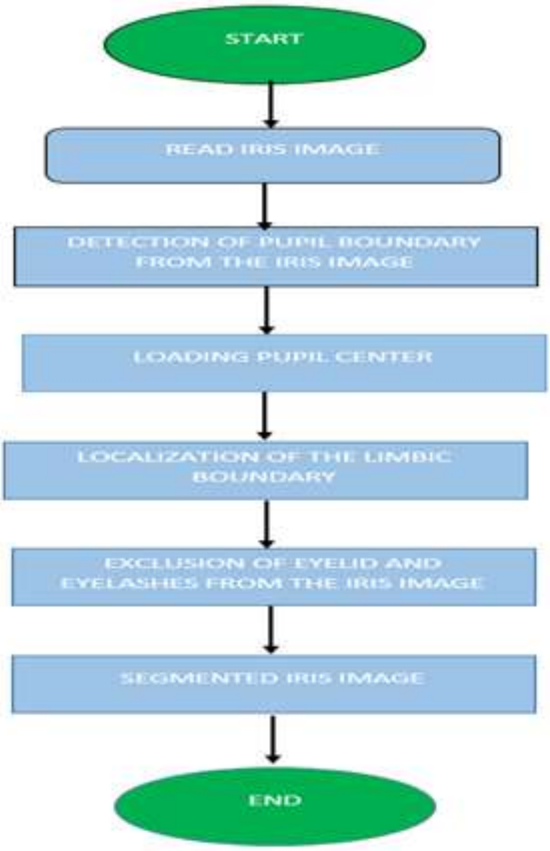
Image acquisition is the process of acquiring high-definition iris images either from an iris scanner or pre-collected images. These images should clearly show the entire eye, especially the iris and novice part. Standard Iris cameras operated in the visible and infrared light band may be used for the Acquisition of Iris Images. Acquisition of Iris Image can be achieved by manual or automatic method. In the manual method, to obtain a clear iris focus the person needs to adjust within six to twelve inches from the camera, while in the later method set of cameras is used to locate the iris automatically. To enhance the quality of captured images Preprocessing steps like histogram equalization, filtering, and standard noise removal to remove the noise may be employed. The various cameras to be selected for Iris acquisition are LG make Iris access 3000, LG 2200, and LG 4000 cameras with features such as autofocus, auto-zoom, and interface for voice. Panasonic makes ET 3000 with features having dual eye camera, and oblique illumination so that eyeglasses may not be removed for acquiring iris image. Oki makes Iris pass M camera has the facility to adjust height and position to find the tilted eye. Iris guard makes H100 camera has LCD, USB interface along with autofocus and auto zoom facility. Security metrics make PIER handheld cameras deployed in the military and police. Iris Access iCam 7 Series is also the best camera for iris acquisition, IrisKing IKEMB-100, Panas BM –ET100, Nikkon E5700, Cannon 5D; Sony DSC –F717, Sony Dxc950p, and Topcon TRC501A, are the other commercial camera adopted for iris acquisition.

BOUNDARY SEGMENTATIONS OF IRIS AND PUPIL

The outcome of the acquisition and eye localization stage will yield a series of images of sufficient quality, followed by the next stage of iris recognition, to isolate the actual iris region in a digital eye image. The iris region can be approximated by two circles, one for the iris/sclera boundary and another, interior to the first, for the iris/pupil boundary. The eyelids and eyelashes normally occlude the upper and lower parts of the iris region. Also, specular reflections can occur within the iris region corrupting the iris pattern. A technique is required to isolate and exclude these artifacts as well as to locate the circular iris region. The imaging quality of eye images decides the level of the success rate of segmentation. The segmentation becomes highly impossible for a person with darkly pigmented irises under very low contrast between the pupil and iris region if imaged under natural light. The segmentation stage is critical to the success of an iris recognition system since data that is falsely represented as iris pattern data will corrupt the biometric templates generated,

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 8 Aug. 2022, pp: 1111-1120 www.ijaem.net ISSN: 2395-5252

resulting in poor recognition rates. Figure 2.1 shows the flowchart for the iris segmentation [4].



Flowchart for Iris Segmentation

The iris segmentation process can be achieved using various standard computer vision algorithms by careful selection of critical parameters of simple geometric objects, such as lines and circles, present in an image that follows

Hough Transform:

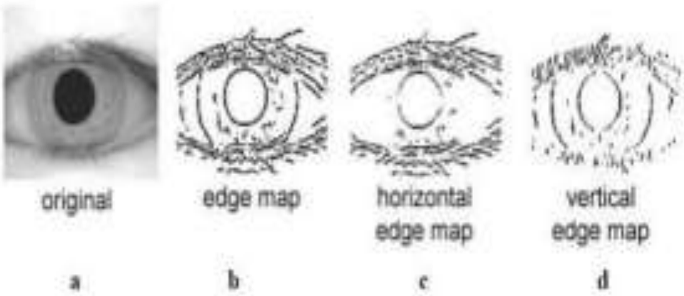
The radius and Centre coordinates of the pupil and iris regions can be deduced by employing the circular Hough transform. An automatic segmentation algorithm based on the circular Hough transform is employed by Wildes et al., Kong and Zhang, Tisse et al., and Ma et al. Firstly, the first derivatives of intensity values in an eye image must be calculated to generate an edge map and then thresholding the result. From the edge map, the parameters of circles passing through each edge point are identified by casting the votes in Hough space. To define any circle these parameters are considered as the center coordinates xc and yc, and the radius r, which according to the equation:-
xc2 + yc2 – r2 = 0

The radius and center coordinates of the circle best defined by the edge points correspond to a maximum point in the Hough space. The parabolic Hough transform by Wildes et al. and Kong and Zhang can be made use of to detect the eyelids, approximating the upper and lower eyelids with parabolic arcs, which are represented as:

$(-(x - h\,j)\ \sin\theta j + (y - kj)\ \cos\theta j)2 = aj((x - h\,j)\cos\theta j + (y - kj)\sin\theta j)$

Where aj controls the curvature, (hj, kj) is the peak of the parabola and θj is the angle of rotation relative to the x-axis. In performing the preceding edge detection step, Wildes et al. bias the derivatives in the horizontal direction for detecting the eyelids, and in the vertical direction for detecting the outer circular boundary of the iris, this is illustrated in the below figure

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 8 Aug. 2022, pp: 1111-1120 www.ijaem.net ISSN: 2395-5252



a) an eye image (020_2_1 from the CASIA database)
b) corresponding edge map
c) edge map with only horizontal gradients
d) edge map with only vertical gradients.

To avoid the corruption of the circular iris boundary edge map from the gradient data, the eyelids are usually horizontally aligned, and only the vertical gradients are taken for locating the iris boundary which in turn will reduce the influence of the eyelids when performing circular Hough transform, and not all of the edge pixels defining the circle are required for successful localization. Due to fewer edge points involved to cast votes in the Hough space, it results in an efficient and highly accurate circle localization. The critical drawbacks of the Hough transform method involve, selecting the threshold values for edge detection, resulting in the removal of critical edge points and thereby failing to detect circles/arcs. The 'brute-force' approach involved makes Hough transform computationally intensive and unsuitable for real-time applications.

Daugman's Algorithm Method:
The circular iris and pupil regions, and also the arcs of the upper and lower eyelids are located using Daugman's integrodifferential operator. The integrodifferential operator is defined as

$$\max_{(r,x_p,y_o)}\left|G_\sigma(r)*\frac{\partial}{\partial r}\oint_{r,x_o,y_o}\frac{I(x,y)}{2\pi r}ds\right|$$

Where I(x, y) is the eye image, r is the radius to search for, Gσ(r) is a Gaussian smoothing function, and s is the contour of the circle given by r, x0, y0. The operator varies the radius and center x and y position of the circular contour search for the circular path where there is the maximum change in pixel values. To attain precise localization the operator is applied iteratively by a progressive reduction in the image smoothening. Eyelids are localized similarly, with the path of contour integration changed from circular to an arc. Like the Hough transform, The Integrodifferential operator too makes use of the first derivatives of the image and performs a search to find geometric parameters. Since it works with raw derivative information, it does not suffer from the thresholding problems of the Hough transform. But the algorithm fails with the presence of noise in the eye image in the form of reflections and being workable only on a local scale [6]

Multiscale Edge Detection Technique:
The two different regions are identified by the edge. A highly remarkable change in the local intensity of the image between the neighboring points which are close to the edge constitutes an edge point: such a point could therefore be characterized as a local maximum of the gradient of the image intensity and need to be applied to differentiable images. The resolution of an image is directly related to the appropriate scale for edge detection. High resolution and a small scale will result in noisy and discontinuous edges while the contrary will result in undetected edges. Multiscale edge detection can be formalized through a wavelet transform to preserve the edges of higher significance across the scales. The edges of lower

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 8 Aug. 2022, pp: 1111-1120 www.ijaem.net ISSN: 2395-5252

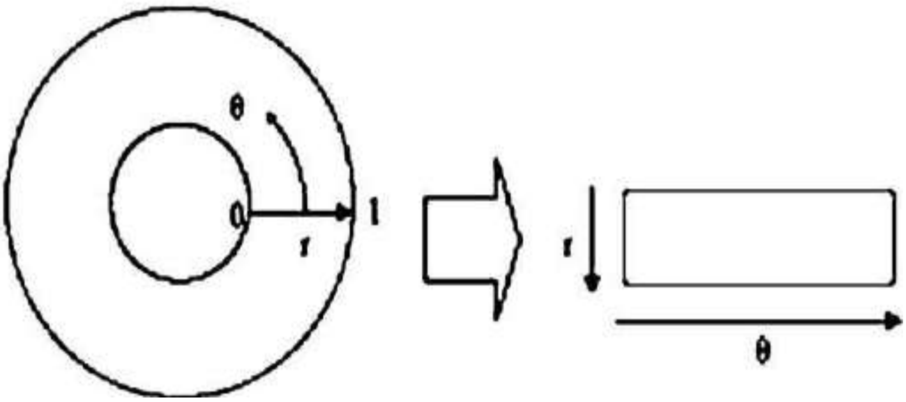
significance are more likely to disappear when the scale increases. This wavelet essentially implements the discretized gradient of the image at different scales. The multiscale edge detection first detects an edge map to identify the iris and pupil boundaries. To enhance the overall performance, the system considers the eyelids and eyelashes isolated from the iris image as noise. The linear Hough transform allows the maximum isolation of eyelid regions drawing intersecting horizontal line that is closest to the pupil. Multiscale edge detection is then used to create the edge map and only the horizontal gradient information is taken. If the greatest in the Hough freedom is lesser than a set threshold, then no procession is fixed, since this corresponds to the eyelids. Also, the lines are restricted to lie exterior to the pupil region and interior to the iris region.

NORMALISATION

The successfully segmented iris region from an eye image has to be transformed into a fixed dimension image to allow comparisons. The stretching of the iris caused by pupil dilation from varying levels of illuminations, varying imaging distance, rotation of the camera, head tilt, and rotation of the eye within the eye socket may result in dimensional inconsistencies between eye images. Normalization of the pupil region is the only solution to compromise the possible variations in the size of the iris image, due to the above factors during the enrollment phase and authentication phase. The main mantra of any working iris recognition system is the fact that the diameter of the pupil remains constant irrespective of the capturing environment. The test image is compared against every individual image residing as a sample in the trained dataset. The ratio of the maximum pupil radius or diameter in the test image to that of the maximum pupil radius or diameter in the trained image is calculated. This ratio is used to normalize the test image to extract the feature from irises of the same radius or diameter. The test image is proportionally scaled using the normalizing factor to have the same radius or diameter as that of the trained image [5]. The normalization process will produce the same constant dimensioned iris regions, where the two photographs of the same iris under different conditions will have characteristic features at the same spatial location. Another point of note is that the pupil region is not always concentric within the iris region, and is usually slightly nasal. This must be taken into account if trying to normalize the 'doughnut-shaped iris region to have a constant radius. The standard iris normalization algorithms include the following:

Daugman's Rubber Sheet Model:

The homogenous rubber sheet model devised by Daugman performs a point-wise transformation of the iris region to a pair of polar coordinates (r, θ) where r is on the interval [0, 1] and θ is angle [0, 2π]. Figure 2.2.1 shows the Daugman's Rubber Sheet Model.



Daugman's Rubber Sheet Model

The remapping of the iris region from (x, y) Cartesian coordinates to the normalized nonconcentric polar representation is modeled as:

$I(x(r,\Theta),y(r,\Theta)) \rightarrow I(r,\Theta)$

With

$x(r,\Theta) = (1-r)xp(\Theta) + rxl(\Theta)$

$y(r,\Theta) = (1-r)yp(\Theta) + ryl(\Theta)$

Where I(x, y) is the iris region image, (x, y) is the original Cartesian coordinates, (r, θ) are the corresponding normalized polar coordinates and are the coordinates of the pupil and iris boundaries along the θ direction. The daughman's rubber sheet models the iris region as a flexible rubber sheet with the iris boundary as an anchor and the pupil center as reference producing a normalized iris representation with constant dimensions. Except for the rotational, the homogenous rubber sheet model accounts for all other inconsistencies like pupil dilation, imaging distance, and non-concentric pupil displacement. The rotational inconsistency in the Daugman system is accounted for during matching by shifting the iris templates in the θ direction until two iris templates are aligned.

Where I(x, y) is the iris region image, (x, y) is the original Cartesian coordinates, (r, θ) are the corresponding normalized polar coordinates and are the coordinates of the pupil and iris boundaries along the θ direction. The daughman's rubber sheet models the iris region as a flexible rubber sheet with the iris boundary as an anchor and the pupil center as reference producing a normalized iris representation with constant dimensions. Except for the rotational, the homogenous rubber sheet model accounts for all other inconsistencies like pupil dilation, imaging distance, and non-concentric pupil displacement. The rotational inconsistency in the Daugman system is accounted for during matching by shifting the iris templates in the θ direction until two iris templates are aligned.

The iris images are first scaled to have a constant diameter in the Boles [7] system when comparing the test image with the trained image. This works differently from the other techniques since normalization is postponed to the matching of two iris regions, rather than performing normalization and saving the result for later comparisons. The features are extracted from the equidimensional iris region by storing the intensity values along virtual concentric circles, with origin at the center of the pupil.

A normalization resolution where the number of data points extracted from each iris is the same must be selected. This is essentially the same as Daugman's rubber sheet model, however scaling is at match time, and is relative to the comparing iris region, rather than scaling to some constant dimensions. Boles system does not take into account the, rotational invariance of the iris.

LOCAL FEATURE EXTRACTIONS

Gabor Filter Technique: The iris model is unique with no two irises of the same individual being alike, and is essentially stable during an entire duration. Gabor filters to the iris image extract the phase features, known as the Iris Code using a 2D wavelet transform at various resolution levels of concentric circles on the iris image. They characterize the consistency of the iris with a zero-crossing representation. The ordinal measures for iris representation are the best choice against Gabor phasors to boost iris recognition. There are however too many parameters that need tuning when using ordinal measures and constructing an optimal classifier is a difficult problem. The authors suggest the use of similarity oriented boosting.

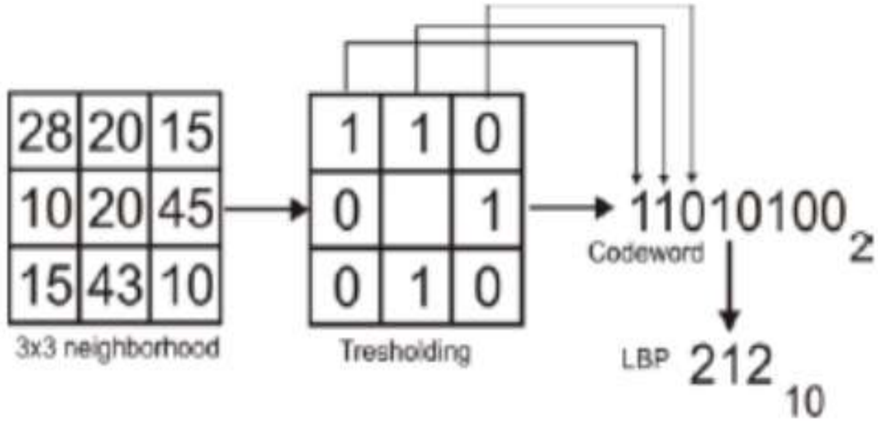
Wavelet Encoding: Wavelets can be used to decompose the data in the iris region into components that appear at different resolutions. The advantage of wavelets over traditional Fourier transform is the localization of the frequency data, allowing features that occur at the same position and resolution to be matched up. Several wavelet filters, also called a bank of wavelets, are applied to the 2D iris region, one for each resolution with each wavelet a scaled version of some basic function. The output of applying the wavelets is then encoded to provide a compact and discriminating representation of the iris pattern.

Haar Wavelet Lim et al. [8] also use the wavelet transform to extract features from the iris region considering both the Gabor transform and the Haar wavlet. From multi-dimensionally filtering, a feature vector with 87 dimensions, with each dimension having a real value ranging from -1.0 to +1.0 is computed, and the feature vector is sign quantized so that any positive value is represented by 1, and negative value as 0. This results in a compact biometric template consisting of only 87 bits. Lim et al. compared the use of Gabor transform and Haar wavelet transform and showed that the recognition rate of Haar wavelet transform is slightly better than Gabor transform by 0.9%.

Laplacian of Gaussian Filters The Wildes et al. system performed the feature encoding by decomposing the iris region by applying Laplacian of Gaussian filters to the iris region image. the filtered image is represented as a Laplacian pyramid which compressed the data so that only significant data remains. The four different resolution levels are required to construct a Laplacian pyramid generating a compact iris template.

Local Binary Pattern In Local Binary Pattern (LBP), the iris area is first divided into small regions from which the Local Binary Pattern (LBP) operator is computed. For that operator need to construct the histogram and finally extract those LBP histograms and concatenated them into a single, spatial enhanced histogram representing the iris image. Here Features are extracted from each region. Local Binary Pattern operator with eight neighbors of pixels, using center pixel value as the threshold value. Compare a neighbor pixel with a center pixel. If a neighbor pixel has a higher gray value than the threshold value then one is assigned to that pixel, otherwise, it gets zero value. Then concatenate these eight ones or zeroes into binary code and calculate the corresponding decimal value and then replace the center pixel with the decimal value as shown in Figure 2.4.1 Where,

S(x) = {1 x (i) > x (c)
{0 x (i) < x (c).



Local Binary pattern

LBP operator increases the intra-class variance which is undesirable for iris recognition. Intra-class variance increases due to discrimination of bright faces against dark backgrounds and vice-versa. This problem is avoided by mapping the minimum of LBP codes and their Compliment using the Robust LBP technique.

CLASSIFICATION AND MATCHING

Matching determines how closely the produced code matches the encoded features stored in the iris database.

Hamming distance: The Hamming distance gives a measure of how many bits are the same between two-bit patterns. Using the Hamming distance of two-bit patterns that are generated from the actual iris region, a decision can be made as to whether the two patterns were generated from different irises or the same one. Since an individual iris region contains features with high degrees of freedom, each iris region will produce a bit pattern that is independent of that produced by another iris, on the other hand, two iris codes produced from the same iris will be highly correlated.

If two bits patterns are completely independent, such as iris templates generated from different irises, the Hamming distance between the two patterns should equal 0.5. This occurs because independence implies the two-bit patterns will be random, so there is a 0.5 chance of setting any bit to 1, and vice versa. Therefore, half of the bits will agree and half will disagree between the two patterns. If two patterns are derived from the same iris, the Hamming distance between them will be close to 0.0, since they are highly correlated and the bits should agree between the two iris codes.

Weighted Euclidean distance The weighted Euclidean distance (WED) can be used to compare two templates, especially if the template is composed of integer values. The weighting Euclidean distance gives a measure of how similar a collection of values is between two templates.

Weighted Euclidean distance The weighted Euclidean distance (WED) can be used to compare two templates, especially if the template is composed of integer values. The weighting Euclidean distance gives a measure of how similar a collection of values is between two templates.

III. SUMMARY OF THE WORK

This section provides the performance rate of various algorithms existing for the iris recognition system. The accuracy of algorithms is tested using MATLAB and CASIA Iris Image Database. CASIA Iris Image Database is a public domain dataset. The database contains 758 iris images from 106 persons for testing. For 8 images of the eye captured with 4samples as training and the remaining 4 samples taken for testing the accuracy is obtained by the error rates which are

EER (Equal Error Rate), FAR (False Acceptance rate), FRR (False Rejection Rate).

Group	EER	FAR/FRR	Accuracy
Daugman	0.95	0.01/0.09	99.9
Hamed	2.4	1.6/1.2	98.1
Li Ma	4.74	0.02/1.98	98.00
Avila	3.36	0.03/2.0	97.89
Tisse	5.95	1.84/8.79	96.61
Wilde's etal	1.77	2.4/2.9	95.10

Performance rate of Iris algorithms

Daughman gives more than 99.9% rate of accuracy and an execution time of less than 1sec. It uses a thresholding technique to detect the iris from the pupil and the boundary. Li Ma et al evaluate the rate of performance FAR is 0.02 and FRR is 1.98.Wildes uses the first derivative and obtains an accuracy of 95.10%. Boles uses zero intersection and the performance rate obtain is 94.33%. Avila and Tisse algorithm gives overall accuracy of 97.89%and 96.61%. The overall accuracy achieved in the recognition of 4 training samples is 99.9% using daugman 's algorithms which maximum rate among all algorithms as shown in table 3.1[1].

IV. CONCLUSION

This study is effective in understanding various algorithms used for Localization, Segmentation, Normalization, Feature Extraction, and Matching of iris code which are the main steps in an iris recognition system. This survey identified that most of the algorithm techniques used to provide good results, yet there is scope to improve the results. This paper will be useful for a researcher who wishes to view a larger picture of the current state of the Iris recognition system, as this paper covers right from the type of camera to be used for image acquisition to the list of algorithms that may be used for research in the iris recognition system. Doughman's algorithm is there with the highest accuracy of 99.9% and Kaushik Rai's algorithm with 99.5%. For future scope, only thing is to decrease the computational time and to obtain the same efficiency of no. of features. One can overcome the deficiency of existing algorithms.

REFERENCES

[1]. Rahmatallah Hossam Farouk, Heba Mohsen, Yasser M. Abd El-Latif (2022), **2**022 5th International Conference on Computing and Informatics (ICCI)**,** INSPEC Accession Number: 21758041, DOI: 10.1109/ICCI54321.2022.9756079, Publisher: IEEE

[2]. **Joshua Oyeniyi , Oluwashina Oyeniran , Lawrence Omotosho , Olajide Adebayo (2020),** Iris Recognition System: Literature Survey and Technical Overview. International Journal of Engineering and Artificial Intelligence Vol 1 No 3 (2020) 34–43

[3]. Sangeeta Soni, Ajay Kumar Singh. (2017). Survey on Methods used in Iris Recognition System. Journal of Image Processing and Artificial Intelligence Volume 3 Issue 1, Page 1-8.

[4]. Sandeep Patil, Shreya Gudasalamani, Nalini C. Iyer, International Conference on Electrical, Electronics, and Optimization Techniques (ICEEOT) – 2016.

[5]. K. Kade Mahesh, P. V. V. Kishore and J. Karande Kailash(May 2017). Indian Journal of Science and Technology, Vol 10(19),www.indjst.org.

[6]. Supriya Mahajan, Karan Mahajan(2017), A Survey on IRIS Recognition System: Comparative Study, International Journal on Recent and Innovation Trends in Computing and Communication ISSN: 2321-8169 Volume: 5 Issue: 4, http://www.ijritcc.org.

[7]. Nalini C. Iyer, Vishwanath G garagad.A Novel Technique of Iris Identification for

Biometric Systems, www.researchgate.net. DOI:10.1109/ICACCI.2014.6968623.

[8]. J. Daugman. How iris recognition works. Proceedings of 2002 International Conference on Image Processing, Vol. 1, 2002.

[9]. W. Boles, B. Boashash. A human identification technique using images of the iris and wavelet transform. IEEE Transactions on Signal Processing, Vol. 46, No. 4, 1998.

[10]. S. Lim, K. Lee, O. Byeon, T. Kim. Efficient iris recognition through improvement of feature vector and classifier. ETRI Journal, Vol. 23, No. 2, Korea, 2001.