A Detailed Survey on Iris Recognition System and Segmentation Methods

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ABSTRACT

Utilizing a person's physiological and behavioral characteristics to identify them is known as biometrics recognition. Numerous biometric characteristics have been developed and are currently being used to verify a person's identity. When compared to other biometric recognition systems, the Iris feature of identical twin eyes makes it a more secure method of authentication. As a result, the iris recognition system is widely used and has been shown to be effective at recognizing individuals with high accuracy and nearly perfect matching. The identification performance of iris recognition techniques has recently improved significantly. Iris recognition systems have garnered a lot of attention among authentication methods due to their robust standards for identifying individuals and their rich iris texture. A standard framework for an iris recognition system is presented in the paper. The methods used in various stages of the iris image recognition system are discussed in this article. The anatomy of the iris, the general procedure, the system's applications, and publicly accessible iris image datasets are all covered in great detail in this paper.

Keywords

Image, iris recognition system, segmentation, biometrics, clustering, classification

1. INTRODUCTION

During image research and application, individuals are only interested in a subset of the image. These elements, which are typically referred to as a target or foreground (an additional element is referred to as background), typically correspond to the image in a particular and distinct way. In order to identify and analyze the object, it must extract and separate them. Based on this, it can be used for the target in the future [1]. We have introduced the "image engineering" concept to illustrate the level of image segmentation in image processing. This concept unifies the relevant theory, methods, algorithms, tools, and equipment of image segmentation into a unified framework [2]. There is a lot of content in the new area of image engineering research and application. It can be broken down into three levels based on the various abstract degrees and research methods used: Understanding, image processing, and image analysis Figure 1.1 demonstrates that image processing emphasizes image transformation and enhances image visual effects. The most important aspect of image comprehension is further investigation into the nature of each target and their relationship to one another, as well as the acquisition of an explanation of the objective scenario for the original image as a guide and plan of action [3]. Image analysis primarily consists of monitoring and measuring the targets that are of interest in the image in order to obtain its objective information and construct a description of the image.

Figure 1 gives an illustration of the operational differences between image processing, image analysis, and image comprehension. Image processing involves relatively low-level operations [4]. It operates primarily at the pixel level. The middle level of image analysis focuses on measuring, expressing, and describing the target [5]. Image Understanding is primarily a high-level operation that focuses on the operation [6] and interpretation of data symbols that are independent of the description [7]. From image processing to image analysis, image segmentation occupies a significant position [8]. It has a significant impact on the measurement of features and serves as the foundation for target expression.

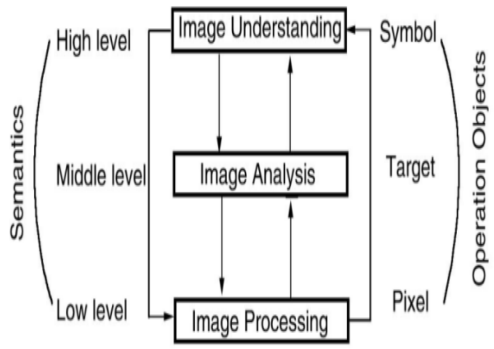

Fig 1: Image Engineering

High-level image analysis and understanding, on the other hand, can be achieved through image segmentation, target expression based on segmentation, feature extraction, and parameter measurement, which transform the original image into a more abstract and compact form [9]. for instance, the use of satellite image processing in remote sensing; the medical applications of MR imaging of the brain; the region segmentation of illegal vehicle plates in traffic image analysis; the image region of interest extraction in content-based image retrieval and object-oriented image compression [10].

2. REGION BASED METHODS

Image division procedures or strategies are characterized into two principal classes [11]

- Layer-Based Segmentation Methods- This method is used for both object detection and image segmentation and composites the output of a bank of object detectors to define shape masks and explain the appearance, depth ordering, and that evaluates both class and instance segmentation [12].
- Block-Based Segmentation Methods- These methods are based on the image's various features. This could be information about colors that is used to make histograms, information about pixels that show edges or boundaries, or information about texture.

As depicted in figure 2, there are two categories of Block-Based Image Segmentation techniques.

- Region Based Methods
- Edge or Boundary Based Methods

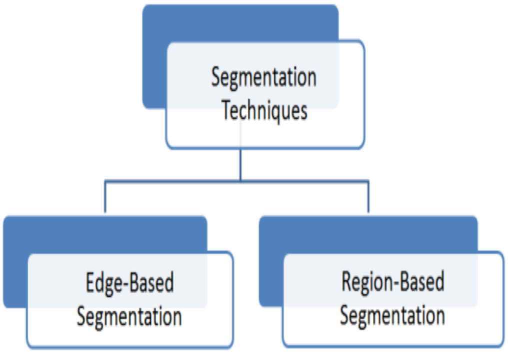

Fig 2: Classification of segmentation Techniques

2.1 Region Based Methods

Separate the entire image into subregions or clusters, such as putting all of the pixels with the same level of gray in one area. Methods based on regions rely on continuity. These methods divide the entire image into subregions based on certain rules, such as the requirement that all of the pixels in a region have the same gray level. Region-based methods work by looking for patterns in the intensity values of a group of pixels that are close together [13]. The region is the cluster, and the segmentation algorithm's goal is to group the regions by their anatomical or functional roles.

2.1.1 Clustering Technique

This method divides an image into K groups or clusters. After taking the mean of each cluster, each point p is added to the cluster with the smallest difference between the point and the mean. Because it is based on hue estimates, clustering is typically used to break up a scene into different objects [14]. The clustering algorithm for image segmentation is difficult to generalize because its performance is highly dependent on the features used and the kinds of objects in the image.

2.1.2 Split and Merge Technique

It consists of two steps: first, the image is divided according to some criteria, and then it is merged. The entire image is initially taken as a single region, and then standard deviation is used to calculate a measure of internal similarity [14]. Thresholding is used to divide the image into regions if there is too much variation. This is done again until there are no more splits that can be done. A common data structure for splitting is the quadtree.

2.1.3 Normalized Cuts

It is developed by Jianbo Shi and Jitendra Malik, are primarily utilized for the segmentation of medical images. Graph theory is the foundation of this method. Normalized cuts aim to split in the best possible way. In a graph, each pixel is a vertex, and adjacent pixels are linked by edges. The similarity of two corresponding pixels is used to assign weights to the edges [15]. Different applications have different requirements for similarity.

2.1.4. Region Growing

One of the most well-liked approaches to image segmentation among the many that have been proposed is region growing. Beginning with a single pixel, this approach will continue to add pixels to the region based on their similarity [16]. When a region stops growing, a new seed pixel that doesn't belong to any other region is chosen, and the process is started all over again. The entire procedure is repeated until every pixel is in a specific region.

2.1.5 Thresholding

It is the most straightforward method of segmentation. The range values, which are applied to the intensity values of the image pixels, can be used to classify regions using the thresholding technique [17]. Thresholding is the oldest segmentation technique and is still widely used in straightforward applications. It is also fast and computationally inexpensive.

2.2. Edge or Boundary Based Methods

Using changes in the images' grey tones, edge detection techniques transform images into edge images. Edges indicate ending and lack of continuity. The components of an object vary in color level [18]. Edges are local changes in the intensity of the image, and they occur at the border of two regions. Discontinuity-based segmentation techniques look for sudden shifts in the intensity value. Edge or boundary-based methods are the names given to these techniques.

2.2.1 Edge Detection Steps

There are various edge detection steps which are described below:

- Filtering- It removes irrelevant information known as noise, which is a random variation in intensity values. More noise filtering causes edge strength to decrease.
- Enhancement- By determining how the intensity of points in a neighborhood changes, it makes it easier to find edges.
- Detection- It uses the gradient's nonzero value to identify edges and non edges points in an image.

2.2.2 Edge Detection Methods

There are various edge detection methods. Some of them are described below.

2.2.2.1 The Roberts Detection

Cross operator carries out a straightforward; quick to calculate, the point output pixel values at each are the magnitude of the input point's spatial gradient, as shown in figure 3.

+1	0
0	-1

Gx

0	+1
-1	0

Gy

Fig 3: Roberts Mask

2.2.2.2 Prewitt Detection

Calculate the 3x3 neighborhoods for eight directions to estimate an edge's magnitude and orientation, and then select the largest convolution mask, as shown in figure 4.

G_x=

-1	0	1
-1	0	1
-1	0	1

G_y=

-1	-1	-1
0	0	0
1	1	1

Fig 4: Prewitt Mask

-1	-2	-1
0	0	0
1	2	1

G_x

-1	0	1
-2	0	2
-1	0	1

G_y

Fig 5: Sobel Mask

2.2.2.3 Sobel Detection

One kernel, 3x3, is the other rotated by 90° as figure 5.

2.2.3 Edge Detection Soft Computer approaches

- The fuzzy logic-based approach- It divides pixels into fuzzy sets, meaning that each pixel may be part of multiple sets and image regions.
- The Genetic Algorithm Approach- It is based on the theory of evolution and consists of three primary operations: mutation, selection, and crossover GA is used in applications that recognize patterns. Fitness functions for fuzzy GA were considered.
- Neural Network Approach- Neural networks and other AI techniques differ significantly in their capacity to learn and generalize. By adjusting the weights and interconnections between layers, the network "learns" and produces relevant output for a set of input data.

3. IRIS BIOMETRICS

Conduct biometrics alludes to the estimation of information got from activities performed by the client and, in this way, gauges the attributes of the human body in an aberrant manner [19]. The following are a few instances of conduct biometrics:

- Way of walking
- Way of writing
- How to type
- How to use the computer mouse
- Voice

Physiological biometrics depends on the immediate estimation of parts of the human body, like the finger impression or iris scanner as shown in figure 6.

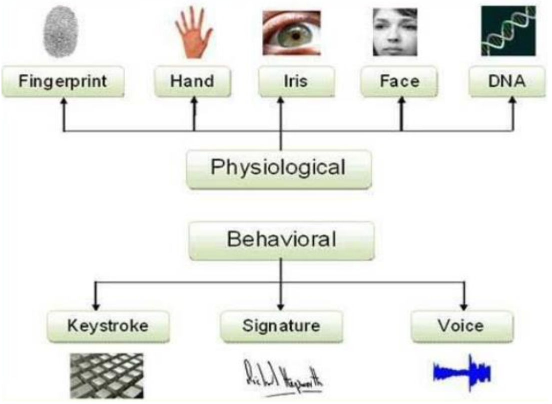

Fig 6: Types of biometrics

The following are a few instances of social biometrics:

- DNA
- Retina
- Fingerprint
- Iris
- Ear
- Face

3.1 IRIS Biometrics

The iris is an internal organ that is protected by the cornea of the eye and is the visible part of the human eye that is responsible for coloring [20]. It is a part of the eyeball. The white part of the eye, the sclera, is surrounded by the iris. The iris's job is to regulate how much light enters the eye. After a certain age, the iris does not change biometrically, one of its most important physiological characteristics, during the aging process. During the third month of pregnancy, the iris begins to form, and its structure does not nearly develop completely until the eighth month [21]. The image is processed to extract the information necessary to create a biometric identity after pre-processing and segmentation, and the characteristics are compared iris and decision making, as shown in figure 7.

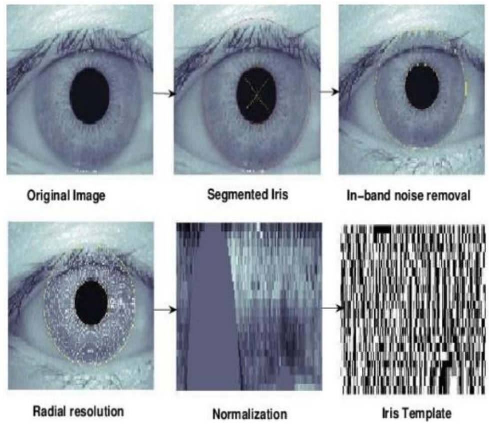

Fig 7: Iris normalization

The iris has the following main advantages:

- It is universal because almost all humans have irises that can be used for recognition, and even people who are blind can be identified by their iris;
- Since there are hardly any identical iris in the world, it is unique;
- Its formation is completed practically during the first few years of life, and it remains unchanged throughout life;
- Because images can be obtained from a comfortable distance, collection is simple.
- a high cost for taking pictures because good pictures of the iris require a complicated camera system;
- Eyelids, eyelashes, iris reflections, and dilated pupils are all factors that can have a negative impact on the result.
- In order for the individual's iris to be correctly positioned and for them to stare at the acquisition device, they must cooperate greatly.
- Recognizing can be difficult if you wear glasses or lenses.

4. DIFFERENT STEPS IN IRIS BIOMETRICS

There are two stages to the iris recognition process. The first phase is the enrollment phase, and the second phase is the matching phase, which can be a process of identification or verification.

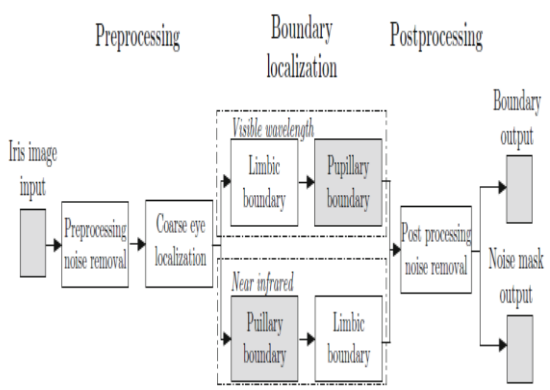

Fig 8: Iris segmentation processing chain: Preprocessing, boundary localization, post processing

During the enrollment process, the pattern of the captured iris is added to the database. The system's overall performance is impacted by the quality of these images. In addition, the stored patterns are contrasted with the input iris image pattern during the matching process. Figure 8 depicts the steps that are included in both of these phases, which include iris image acquisition, iris localization, iris normalization, iris image enhancement, and feature extraction. The database stores the extracted feature vector during the enrollment process.

4.1 Iris localization and segmentation

The image of the iris also includes other parts of the eye, like the eyelid and eyelash, which causes the texture of the iris to be distorted. The elimination of these influencing factors must be accomplished through preprocessing, which includes iris localization and noise removal. The iris inner boundary, which corresponds to the iris/pupil boundary, is localized during the segmentation process, and the iris outer boundary, which corresponds to the iris/sclera boundary, is discovered.

4.2 Feature extraction

Phase based method, zero crossing representation method, and texture analysis method are all subsets of the feature extraction method used for iris recognition. The energy compaction properties of various wavelet transforms can be useful for feature extraction. It has been demonstrated that the most discriminating band pass filters for iris image feature extraction are the gabor filters with carefully chosen parameters. Feature extraction can be done with an edge descriptor like a LOG filter. The eye's pupil can be found using any edge detection method to begin the feature extraction process.

4.3 Classification

Template matching against the stored template is used to classify data for one-to-one or identification-to-many matching verification. Different algorithms, such as Hamming Distance, Euclidean distance, weight vector, dissimilarity function, or neural network, are used to classify the feature vectors during the matching step. After that, identification and verification are performed.

5. IRIS RECOGNITION SYSTEMS

Flom and Safir patented the idea of an automated iris recognition system for the first time in 1987. Daugman later came up with the iris recognition algorithm that is used the most. Daugman's seminal method is frequently regarded as a standard iris recognition system due to its widespread use and high recognition accuracy. Figure 9 provides a summary of the major steps involved in iris recognition. The following sections provide in-depth descriptions of each step:

5.1 Image Acquisition

Near-InfraRed (NIR) illumination with a wavelength of 700 to 900 nm is typically used to capture iris images. Instead of focusing on the iris's pigmentation, images taken with these wavelengths typically emphasize its intricate texture. This contributes to improved recognition performance by effectively capturing the texture of dark-colored iris. The subject must cooperate with conventional iris recognition systems and remain close to the sensor.

5.2 Pre-processing

A number of things can affect the quality of an acquired iris image, such as occlusions, motion blur, and so on. By pre-processing the input image, such factors could be minimized in their impact on recognition performance. Preprocessing steps are optional and highly dependent on the conditions of the image acquisition. As a result, it is important to note that iris pre-processing can vary significantly between systems.

5.3 Segmentation

The iris segmentation module determines the inner and outer boundaries of the iris region from an image obtained by the sensor. Two non-concentric circles, one for the pupillary boundary and the other for the limbic boundary, typically serve as an approximate representation of these boundaries. A circular contour detector is used to accomplish this. The eyelashes on the upper and lower lids can usually hide the iris region.

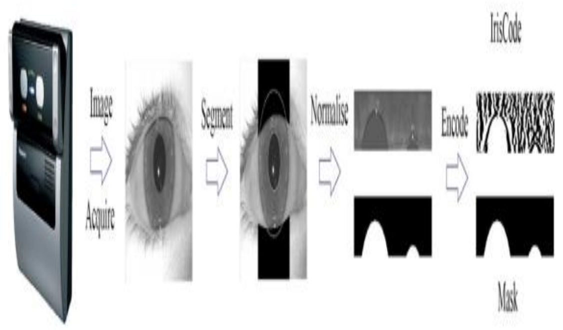

Fig 9: Major steps involved in a conventional iris recognition system

5.4 Normalization

An iris's inner and outer boundaries can have different sizes because the pupil dilates and contracts. Before comparing various iris images, such variations must be minimized [21]. The segmented iris region is typically mapped to a fixed-dimension region for this purpose. Daugman proposed making the segmented iris into a fixed rectangular region by employing a rubber-sheet model.

5.5 Encoding

The process of extracting highly discriminative yet compact features from a normalized image is referred to as encoding [22]. Using quadrature 2D Gabor wavelets, phase information is extracted from the normalized iris to make this process easier. Because amplitude information is not discriminative and is easily influenced by external factors like illumination and camera gain, phase information is used for recognition only.

5.6 Matching

In the matching step, the similarity of two given IrisCodes is evaluated. The Hamming distance between two IrisCodes is used to calculate a similarity score [23]. But in real life, a threshold value is usually used to tell the difference between real and fake IrisCodes. Because the XOR operator is used, the matching process incurs very little computational overhead. Using a 3GHz CPU, it is claimed that the described step could be executed to match up to one million comparisons in one second [24].

6. IRIS RECOGNITION FRAMEWORKS

Access control, internet security, credit card authentication, defense security, scientific laboratories, and many more are just a few of the many uses for the Iris recognition system. The architectural skeleton of any Iris recognition system is the acquisition of an eye image; extracting the Iris region and applying normalization (radial to rectangular conversion) to the live-captured IRIS image in order to match the individual's unique IRIS texture with the enrollment database created during the verification phase. Figure 10 depicts the current Iris recognition system's modules, which include normalization, iris code template matching, iris image segmentation and localization, and feature extraction.

Segmentation- The process of identifying the boundaries of objects in an image is known as segmentation. The segmentation is critical in an iris recognition framework because it separates the iris's inner and outer edges from irrelevant parts of an image.

Normalization- It is the process of unwrapping the segmented iris, transforming it into a polar image—a rectangular block of fixed size—for further processing. Normalization is followed by segmentation.

Feature extraction- Using feature extraction, individuals are identified using the distinguishing information in iris patterns. A feature vector is generated by encoding the patterns' phase information.

Iris code matching- After the feature extraction step, the iris template is compared to the templates in the database using matching metrics, and the individual's identity is determined based on the matching score. Segmentation is a crucial step in the iris recognition system's modules because the information we're looking for will be contained within the iris patterns.

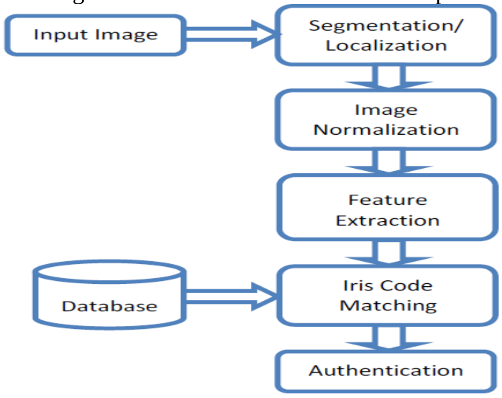

Fig 10: The block diagram of the iris recognition system

7 APPROACHES USED FOR IRIS RECOGNITION

7.1 Integro-differential operator

This approach is viewed as one of the most referred to move toward in the study of iris acknowledgment. Daugman involves an Integrodifferential administrator for portioning the iris. It tracks down both inward and the external limits of the iris area. The external as well as the internal limits are alluded to as limbic and understudy limits. It is having a disadvantage that, it experiences weighty calculation. When discretized in executions, the adjustment of pixel values is assessed and smoothing is dynamically decreased by iterative use of the administrator, as displayed in figure 11.

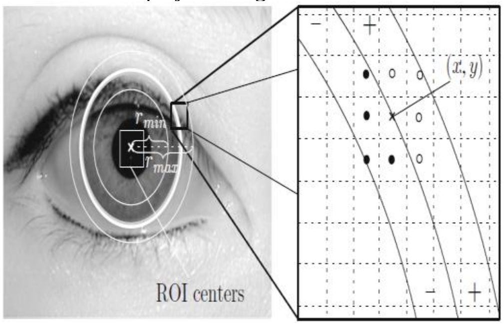

Fig 11: Implementation of Daugman's integro-differential operator

7.2 Hough Transform

The significant difficulties associated with the picture securing are as far as picture goal and furthermore in the center utilizing a few standard optics. Here, a surviving framework has been utilized to give a solution for these difficulties. Next issue is the iris restriction. That is the picture catch during the picture securing will be an extremely bigger picture which contains iris as a piece of it as displayed in figure 12. Subsequently restriction of the part that compares to the iris from gained picture is especially significant.

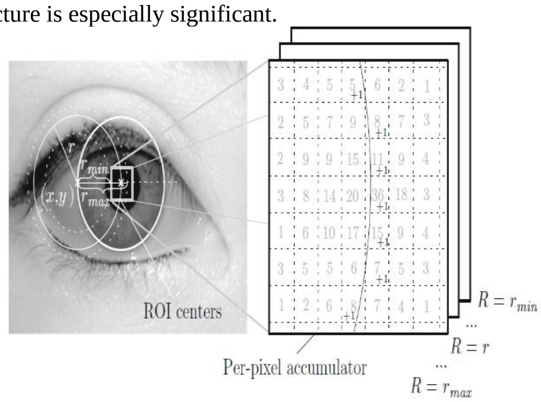

Figure 12: Illustration of the voting step within the circular HT

7.3 Masek Method

Masek introduced an open iris recognition system for confirming the uniqueness of the human iris and its use as biometrics. An automated segmentation system is part of the iris recognition system. It uses an eye image to locate the iris region and separate the eyelid, eyelash, and reflection regions. The circular Hough transform was used to localize the regions of the iris and pupil for this Automatic segmentation, while the linear Hough transform was used to localize the eyelid occlusion. Thresholding has been used to separate the reflections from the eyelashes.

7.4 Fuzzy clustering algorithm

The fuzzy K-means algorithm is used to apply a clustering algorithm after the image-feature extraction step, which extracts three discrete values for each image pixel: (x, y), which represent the pixel position, and (z), which represent its intensity values. After classifying each and every pixel, this was used to create the intermediate image. The edge-detector algorithm then makes use of this correspondent image. This makes it simpler to adjust the edge-detector algorithm-required parameters due to its additional homogeneous characteristics.

7.5 Pulling and Pushing (PP) Method

For iris biometrics, the Pulling and Pushing (PP) Method is a perfect (accurate) and quick iris segmentation algorithm. To begin, a novel reflection removal technique was developed in order to exclude the specularities present in the input images. Additionally, an Adaboost-cascade iris detector was utilized in order to identify the iris in the images and to exclude any parts of the image that did not contain the iris before proceeding with further processing in order to avoid performing redundant computations.

7.6 Eight-neighbor connection based clustering

Eight-neighbor connection based clustering is a novel method for growing regions that attempts to divide the entire iris image into a number of distinct parts. After that, the genuine iris region has been extracted using a number of semantic priors, and non-iris regions like eyelashes, eyebrows, the frame, hair, and soon have also been identified and excluded.

7.7 Segmentation approach based on Fourier spectral density

A new approach to segmentation based on Fourier spectral density A new approach to segmentation based on Fourier spectral density has been proposed in this paper for noisy frontal view iris images that are captured with minimal cooperation. After performing row-wise adaptive thresholding and calculating the Fourier spectral density for each pixel using its neighborhood, this method produces a binary image that fairly accurately depicts the iris region..

7.8 Circular Gabor Filter

The circular Gabor filter, also known as the CGF, has been used to pinpoint the initial pupil center. The fact that segmentation accuracy has been achieved for the pupil and iris boundaries is the main benefit of this method. The overall segmentation accuracy is lower than that of [9], which is a drawback. The iris recognition system's performance has been improved by all of these methods.

Table 1. Table captions should be placed above the table

Method	Performance	Property	Disadvantages
Integrodifferential operator	excellent iris recognition capabilities	Visual identification of individuals with high confidence using a statistical independence test	The computation takes a very long time.
Hough transform	Up to a certain point, segmentation accuracy achieved	Recognition of Iris: A brand-new biometrics technology	Doesn't pay enough attention to EL or the reflections, etc.
Liber Masek's encoding algorithm	The circular iris region, eyelids, eyelashes, and reflections are all localized.	Pattern Recognition for Biometric Identification of Human Iris	The system runs slowly.
Fuzzy clustering algorithm	Improved segmentation for iris recognition that does not cooperate	Non-cooperative recognition using iris segmentation	To identify the circle parameters of the pupil and iris boundaries, a thorough search is required.
Pushing and pulling (PP) method	Be quick and precise.	Iris Biometrics: Towards Accurate and Rapid Iris Segmentation	Errors in segmentation that occur
Eight-neighbor connection based clustering	The accuracy of iris segmentation has been improved to some extent.	Effective and robust iris image segmentation for non-cooperative iris recognition	Improve the noise-free iris image segmentation.
Segmentation approach based on Fourier spectral density	Low computational complexity	Utilizing Fourier spectral density, an efficient method for segmenting iris images from a noisy frontal view	The detection of limbic boundaries needs to be improved.
Circular Gabor Filter	It has been possible to achieve segmentation accuracy for both the pupil and the iris boundaries.	In a Visible Wavelength Environment, Iris Segmentation	The overall accuracy of segmentation is lower than that of the unified framework method.

8. APPLICATIONS OF IRIS RECOGNITION SYSTEM

Several applications can benefit greatly from the capability of performing iris recognition from a distance [24]. The following is a list of sample applications, arranged by their domains.

8.1 Control of the Border

Iris recognition systems are already in use in a number of airports worldwide (including the United Kingdom, Canada, the United Arab Emirates, Holland, Singapore, and others). Passengers (for expediting border control and screening against a watch list) and employees (for access control to restricted areas) are typically scanned by these systems.

8.2 Surveillance

The term "surveillance" refers to the process of keeping an eye on people's actions, thoughts, or other ebbs and flows of information with the intention of influencing, controlling, directing, or protecting them. The creation of applications for automated surveillance, particularly those that make use of biometrics, has received an increase in interest.

8.3 Law Enforcement

Security and crime prevention are two areas of application for IAAD systems in law enforcement. They might make it safer for civilians as well as officials in law enforcement. The CMU Cylab-developed IAAD system, which allows police officers to identify a person without leaving their cars, is a good example of such an application.

8.4 Service Industry

IAAD systems could be used to make banking, retail stores, casinos, and other service businesses more user-friendly. A sample application allows for the identification of customers as they enter a store in order to provide them with personalized sales.

8.5 Military

Hand-held iris recognition devices, such as PIER scanners from SecuriMetrics, are frequently used in military identification tasks on battlefields. Participants need to be very cooperative with these devices. Without imposing many restrictions, IAAD systems could significantly enhance individual monitoring, tracking, and identification.

8.6 Robotics

It is anticipated that service-based robots and humans will interact closely in the future. The capacity of robots to recognize the people with whom they interact can assist in providing individualized service. By reducing user constraints and increasing the distance between interactions, IAAD systems may be able to enhance this kind of experience.

9. LIMITS OF IRIS SEGMENTATION

The following are information about the human iris that should be taken into consideration when developing an iris recognition system. Active contour can be utilized to appropriately determine the boundaries because the inner and outer boundaries are not perfect circles. Second, as nations consider biometric-based security systems, they will face even more stringent requirements. The following are some interesting conclusions that can be drawn from the aforementioned works:

- From the original iris images, all of these methods, including Kong's, detected all possible noise regions. If one wanted to accurately detect all possible noises, it would take more time.

- Despite the fact that Kong's model has shown how to accurately detect reflection and eyelash noises, it has not been tested on a large iris database using the current recognition algorithm;
- When the pupil boundary cannot be approximated as a circle, no method considered how to precisely divide the iris and pupil regions;
- A single algorithm has not been developed to detect all four types of noise, including pupil, eyelashes, eyelids, and reflections;
- The system's processing time is significantly increased because the inner and outer boundaries, eyelashes, and eyelids are detected in distinct steps.
- The inner and outer boundaries are typically identified using circle fitting methods. Because the boundaries of the iris are not exactly circles, this is a source of error.
- The circle fitting method's results are affected by the image's rotation, especially if the input image rotates more than 100 degrees.
- The iris's outer boundary lacks sharp edges in noisy environments.
- The resulting iris area is mapped into a size-independent rectangular shape following the detection of iris boundaries. The disadvantages of the rectangular normalization are numerous.
- A thorough examination of the African iris reveals boundaries that are not properly differentiated, necessitating the modification of one or more of the existing segmentation algorithms in order to correctly recognize these boundaries.

10. PUBLIC IRIS IMAGES

There are numerous public databases of iris images. In this section, we looked at some important iris image databases like CASIA, ICE, UBIRIS, WVU, BATH, and the MMU Database.

10.1 CASIA

Iris Database The Casia iris image dataset (version 1.0) contains 756 images across 108 distinct classes. Seven images were taken in two sessions—the first session yielded three samples and the second session yielded four. The Casia Version 3 dataset includes 396 classes and 2655 images of 249 people. The images were taken in two sessions separated by a month. The images have 8-bit gray intensity levels and are 320 x 280 pixels in size.

10.2 ICE Database

The Iris Challenge Evaluation (ICE) dataset consists of 2954 images divided into 1528 images of the left eye iris and 1425 images of the right eye iris. There are 244 classes in the dataset. Few images of the iris in the ICE database are blurry and show the iris covered by eyelashes and eyelids. Additionally, there are images of the iris partially captured and rotated. With an intensity level of 8 bits, the iris image is 640 by 480 pixels.

10.3 UBIRIS Database

This is a biometric iris dataset. There are a total of 2,410 visible-wavelength iris images in the ubiris Version 1 database. The iris image was taken in two sessions. In order to verify the algorithm's robustness and accuracy, noisy images are also included in the database.

10.4 WVU Database

The West Virginia University (WVU) dataset includes 200 classes and 800 images taken in poor lighting conditions. There are four images in each class, taken from three different perspectives. Images of the iris are 640 by 480 pixels and have an intensity level of 8 bits.

10.5 The Bath Database

The University of Bath's (BATH) iris image database contains more than 16000 images of the iris, out of which 800 eyes were studied on 400 subjects. The primary subjects of this dataset were Bath University staff and students, and a high-quality camera was used.

10.6 MMU Database

The Multimedia University's (MMU) data set only contains 450 images of the iris. There are 100 subjects in the iris image database, each with five iris images of a different age and nationality. Dam University ND IRIS -0405, IIT Delhi, and UPOL have also released useful datasets.

11. CONCLUSIONS

One of the most effective ways to identify a person is to recognize their iris. One of the most reliable and secure methods of authentication is the Iris recognition system. For the purpose of iris recognition, various previously proposed approaches are reviewed in this paper. The benefits of using Iris recognition technology are bolstered by the iris' one-of-a-kindness and low risk of false acceptance or rejection. The majority of solutions involve a few fundamental steps, including eye localization, image segmentation, normalization, feature extraction, and matching. It is also concluded that the IRS has a bright future, which inspires researchers to carry out additional research to find solutions to the aforementioned issues.

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