Iris Recognition using Image Segmentation

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***Abstract*—The system here is implemented and developed in a way to authenticate if two of the individuality of the human iris when compared with iris of other humans is same or different. The iris is the science for the biometric system. It is a unique identification of individuals on the basis of the characteristics and features. The ocular identification system is one of the reliable and précised system in existence. This method uses an automatic approach of segmentation grounded on the Hugh transform to locate the region of pupil and circular iris, with obstruct eyelids and eyelashes, along with reflections. The iris is extracted, filtered and normalized into the circular round block for identification.**

***Keywords*—Iris Recognition, Pupil, Image analysis, MATLAB, segmentation, Sobel filter, canny filter, Eyes, biometric system, normalization.**

1. INTRODUCTION

1.1 Biometric Technology

Iris recognition systems have evolved a lot in the past few decades. This system which is also biometrical based technology used for verification and identification. The growing importance of safety considerations in daily life is becoming increasingly apparent. When it comes to security systems, iris recognition or biometric detection systems are more important than any other. Iris recognition, on the other hand, is dependable and accurate for user authentication. Biometrics has its own characteristics and characteristics. This system of biometric have been prosper on the basis of retinal, facial recognition, geometry of hands etc., Analyzing the various iris patterns might help with recognition. The most basic of biometrics is to collect an input image and extract important features such as texture, color, and so on in order to correctly identify users. The iris, a small intrinsic organ with a delicate and round form, is in charge of controlling the passage of light into the eyes. The iris is employed for identifying purposes after applying segmentation to the input image and then performing feature extraction. The digital version of the image or recording is then transformed by applying mathematical functions into the template of biometrics. The biometric recognition system operates in two modes. Firstly, there is an enrollment mode where addition of templates is done to the database. Next is the identification mode where templates created are compared and matched to yield whether the prototype which pertains to the same person or the template are different iris. The retinal feature doesn't over time, also highly unique which are easily captured with less misinterpretation of features. Features of two identical twins also do not match with each other which makes it most reliable.

1.2 Human Iris

Iris lies between the lens of the human eye and the cornea. It is a thin diaphragm circular in shape. Iris is perforated in the center surrounded by pupils. The iris is for the functioning of the number of lights entering through the center of the pupil, which are operated by two muscles like the dilator and sphincter muscle. The pupil is about 10 to 80% of iris diameter while iris diameter is 12mm. The iris is protected by several layers among which are epithelium layer, stromal layers, ciliary zone and papillary zone. The density of the layer determines the color of the eye. The outer two zones form a zigzag pattern divided by collarets.

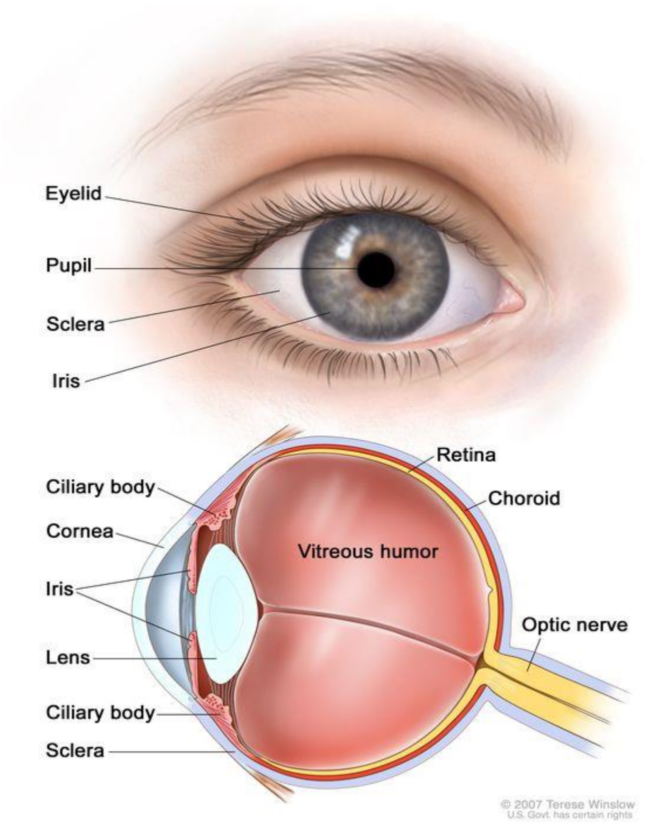

Figure 1.1 Detail view of human eye

1.3 Scope and Applications:

- Password for computer login
- Security access to bank account
- Access to the premises
- For secure financial transactions
- Anti-terrorism
- Use as keys, cards, PINs or password
- Birth certificates; locating a missing or wanted person.

2. LITERATURE REVIEW

Biometric research has gotten a lot of interest in recent years, thanks to a rise in security concerns. People and governments have been encouraged by the rising crime rate to take action and be more proactive in security concerns.Individuals must defend their working environments, residences, personal property, and money, among other things, in order to feel secure. Many biometric approaches have been created and are being improved, with the most successful being used in law enforcement and security applications on a daily basis. Several state-of-the-art approaches are used in biometric procedures. Iris recognition is the most powerful security authentication mechanism currently available.

"Biometrics" comes from the Greek terms "bio" (life) and "metrics" (measurement) [8]. Automated biometric systems have only recently become available as a result of substantial developments in computer and processing technology. Despite the fact that biometric

technology appears to belong in the twenty-first century, biometrics has a lengthy history. In the history of biometrics, the ancient Egyptians and Chinese played a significant influence. To combat terrorism and increase security, biometric face recognition, iris recognition, retina recognition, and identifying traits are now being used.

In 1936, ophthalmologist Frank Burch developed the idea of using the iris pattern for identification (Iradian Technologies, 2003). Woodrow W. Bledsoe developed the first semi-automatic face recognition system in 1960, based on the placement of the eyes, ears, nose, and mouth on photos. Gunnar Fant, a Swedish professor, developed the first acoustic speech production model the same year. Today's speaker recognition technology incorporates his invention (Woodward et al, 2003).

Alphonse Bertillon was the first to suggest iris pattern recognition for personal identification. After that, in 1987, they collaborated with John Daugman to develop iris recognition software. W.Boles, R.Wildes, and R.Sanchez-Reillo conducted more study to identify pattern matching method and iris characteristics representation[2]. Iris detection has been implemented using a variety of ways. The multimodel approach to iris recognition is one of the strategies for iris recognition, however it has the disadvantage of being limited to noise-free images and being inefficient [4]. Another technique for real-time applications is Feature Extraction [5], which has a long computational time. Another option with varying computational time is the neural network approach [6].

To establish the stand-off distance in an iris recognition framework, Sheng-Hsun Hsieh et al. [3] suggested a new hardware-software hybrid approach. When creating the framework hardware, they used an upgraded wavefront coding approach to boost the field depth. To compensate for the image obscuring caused by wavefront coding, the revealed framework applied a local patch focused super-resolution strategy to reestablish the obscured image to its clear variation. While maintaining a high recognition rate, the presented framework has the potential to treble the catch volume of a normal iris recognition framework. The planned model, however, has the problem of being expensive due to the hardware implementation.

Sushilkumar et al. [10] presented Iris recognition using SVM and ANN. For the iris recognition objective, this research employs the methods of ANN and SVM. The process of dividing the iris segmentation region is referred as Hough transform. The photos recovered by Iris are divided into two categories: those that match and those that don't. The system uses this information to determine whether or not the user is authenticated. The categorisation must be extremely precise. After that, there is a pattern matching process. It works reasonably well when the two strategies are combined.

Fully convolutional networks were used by Nianfeng Liu et al. to enable accurate iris segmentation in non-cooperative situations [11]. Iris recognition technologies work in a unique way when the conditions are favourable. It's a very simple task if there's a lot of user collaboration and a cooperative set of criteria. In contrast, it becomes a difficult task in non-cooperative situations, such as those with blur, disruptions, low user participation, and other unforeseen events. As a result, the focus of this work is on iris authentication accuracy in non-cooperative settings. It makes use of completely conventional neural networks as a model. Iris photos with a lot of noise are a real pain. People who are moving make a lot of movements as well. This strategy is utilised in these situations.

Comparison of methods used for iris recognition:

Algorithm	Segmentation	Normalization	Feature Extraction	Matching
Doughman	Integro-Differential Operator	Doughman's Rubber Sheet Model	Gabor's 2-D Filter	Hamming Distance
Wilde's	Gradient based edge detection and Hough Transform	Image Registration	Isotropic Band pass Decomposition	Normalized Correlation
Li Ma	Nearest Feature Line (NFL) method	Doughman Rubber Sheet Model then Iris image enhancement and denoising	(2-D) Even Gabor Filter	Weighted Euclidean Distance

Table 2.1 Comparison of methods used for iris recognition

Roy et al. (2011) suggested a technique for non-ideal iris identification in their paper [7]. Using a level set based curve evolution approach, the pupil is isolated, and the iris is subsequently localized using the Mumford-Shah energy minimization segmentation algorithm. The genetic approach was used to choose feature subset information after deconstructing Daubechies wavelet transforms. To match and control misclassification error, an Adaptive asymmetrical Support Vector Machines (AASVM) was used. The suggested GA reduced the feature dimension without reducing identification rates when evaluated in ICE 2005, the WVU database, and the UBIRIS V1 database.

Cunjian Chen et al. proposed a Multi-task Convolutional Neural Network for Joint Iris Detection and Presentation Attack Detection in their paper [2]. The authors presented a strategy that used a convolutional neural network to detect the iris and conduct PAD in this paper. It proposed a novel idea that could be extensively implemented. It is based on an object detection system that has the potential to suppress factors that are necessary for optimal performance. Sensing and recognition techniques are carried out by sensors at work. It's crucial that the categorisation is spot-on.The pattern matching process follows after that. Another critical component of the system is this. The face features are often so complex and intricate that feature extraction and classification fail to reliably identify the iris. The system may also fail to perform successfully if minor face changes, such as the use of expressions, are made.

3. METHODOLOGY

Iris recognition consists of six different phases. Firstly, a template is formed which can be understood by ML algorithm by converting visual data into desired output. Followed by segmentation where division of digital image into several different subgroups. Feature Extraction is the third stage which is a part of image behavior. Later features are selected by applying variables on the predictive model. Fifth phase is recognizing where the specification is matched with the objects in the picture or the video. Finally, the unmapped and mapped segments are performed on some mathematical function with performance metrics like conversion and impression.

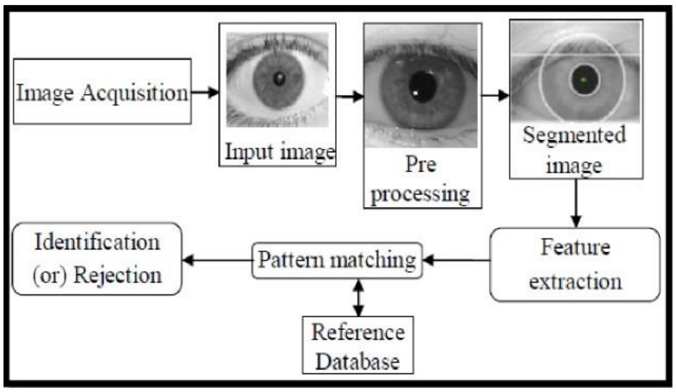

Figure 3.1 Process of Iris Recognition

The strategy proposed in the figure 3.2 is what we aim to use on the photographs in the dataset. For iris recognition, we'll utilize the Daughman's Algorithm segmentation approach. To remove eyelids, eyelashes, reflections, and pupil noises, segmentation is a technique for determining the correct iris region in a given location of the eye. It must be done exactly and correctly. After applying filters and normalizing the image, the application will deliver the output.

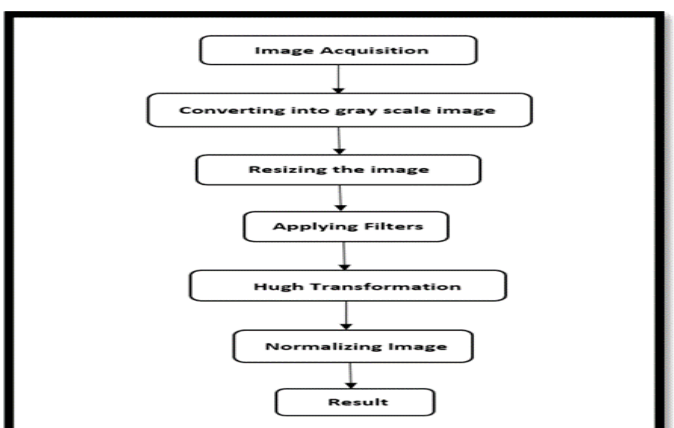

Figure 3.2 Flowchart

In Daughman's Algorithm, firstly we find the coordinate center of the pupil and iris. The theory of border recognition is integro differential equation. The equation is :

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

Where,
I(x,y) = Pixel intensity ate the x axis and y axis coordinate.
r = radius of circular region with (x0,y0) at center.
σ = SD(Standard Deviation) in Gaussian Function.
s = parameters of the circle with the contour.
Gσ(r) = Gaussian filter

3.1 Acquisition of image

Acquisition of image is crucial since all following/later stages/phases are dependent on the current picture quality of acquisition of the iris image. Conversion or creation of digital image acquisition of physical scene or structure/interior of an object. Acquisition may also include the storage, display, processing or printing. Here images are acquired from an online dataset of the eyes. Also, it is recommended to use the JPEG file format. Resolution is set to 640x480 pixels. The public dataset are:

- The CASIA dataset
- The UBIRIS dataset

3.2 Conversion to grayscale image

Considering a constant image and subtracting the one from the other is commonly referred as converting the grayscale image.
Z=imsubtract(X,Y),
Where difference of array y from array x is stored in the array Z.
Processes included are:

1. Read background and foreground images
2. Convert rgb to hsv
3. Bi-Oring both the images
4. Convert rgb to grayscale

5. Read rows and columns later converting to binary image.
6. Remove noise by applying median filter
7. Remove noise and labeling

3.3 Histogram

Histogram is the graph representation of digital image tone wise distribution. The hist are usually dark with the majority of data points scattered in the hist graph. Here by either discretion or continuous measured of interval scaling is used for data. It is used to visually summarize the important features of data distribution in a convenient format.

3.4 Cropping and Resizing the image

Removal of the exterior or outer section of a digital image to improve the framing and get a better aspect ratio is called cropping image. J=imcrop(). Scaling the image to get desired output would help and also won’t change the number of pixels in the image.

3.5 Smoothing with Gaussian Filter

Gaussian filters are good at reducing noise. Such filters are isotropic where SD is the same along all dimensions. Here scalar value for sigma is used. Low Pass Filtering helps in removing high spatial freq noise from digital images. This filter puts the moving window which affects a single pixel at any time.

Advantages of Gaussian Filter:

- There are no complex algorithms requiring several nested for loops.
- Some use cases may need hiding someone's identity or censoring photographs that contain content that is offensive to particular audiences. In these circumstances, Gaussian smoothing is ideal.
- A rotationally symmetric image is obtained using Gaussian smoothing. It is used in the same way regardless of which way you go.

3.6 Edge Detection with Canny Filter

This filter helps in finding the periphery/ boundary of the object within the image. Works majorly by detecting the light discontinuity. This filter is used in computer vision, machine vision, and processing.

The following are some general criteria for edge detection:

- Edge detection has a low error rate, which indicates that the detection should catch as many of the image's edges as possible.
- The edge point recognized by the operator should be accurate in locating the edge's center.
- When possible, picture noise should not cause false edges, and each edge in the image should only be marked once.

3.7 Segmentation of Image

Image segmentation, in human perception, is the process of splitting an image into non-overlapping meaningful sections. The fundamental goal is achieve several different portion by doing image segmentation analysis, allowing us to gain only the facts we need. The division of a huge image into several segments simplifies further processing, hence segmentation is significant in image processing. The image will be covered by these many pieces that have been connected. The image's color or texture may also influence segmentation.

Set of pixel / super pixel is often referred to as the process of partitioning the image digitally into multiple segmentation. It helps in achieving the goal image by applying meaningful analysis. It usually locates curves, lines in the image. Each pixel in the segmented image would yield properties like intensity, color or texture. Such variation in the digital image helps in getting the low and high intensity which later simplify the edge detections procedure.

3.8 Sobel Edge Detection

The gradient approach for identifying specific changes in the image 1^{st} derivative is the sobel filter. The Sobel edge detector employs a pair of 3 3 convolution masks, one for estimating the x-direction gradient and the other for predicting the y-direction gradient. When comparing the results of the sobel and Prewitt operators, you'll see that the sobel operator finds more edges or makes them more noticeable.

The Sobel operator's simplicity is one of its main advantages. The gradient magnitude can be approximated using the Sobel method. The Sobel operator can also detect edges and their orientations, which is a useful feature.

3.9 Gamma Adjustment

Gamma correction is a type of image processing that compensates for a capture device's intrinsic tone-reproduction tendencies or prepares an image for output to a monitor or printer, which may also be calibrated in non-linear terms.

Because our eyes interpret color and luminance differently from the sensors in a digital camera, we utilize gamma correction. The signal is doubled when a digital camera's sensor picks up twice as many photons. Our eyes, on the other hand, do not work in this manner.

3.10 Hysteresis Threshold

Hysteresis is a technique for constructing an intermediate image from two images in image processing. The function takes two binary pictures with distinct thresholds. The population of white pixels in the higher threshold is smaller. Real edges are more likely to have values in the higher threshold.

The Canny operator's thresholder employs a technique known as "hysteresis." Most thresholders utilized a single threshold limit, which implies the line will appear broken if the edge values change above and below this number.

3.11 Hough transformation

The Hugh transform is a technique for separating characteristics of a specific shape inside a picture. The classical Hough transform is most typically employed for the detection of regular curves such as lines, circles, ellipses, and so on, because it requires the desired features to be provided in some parametric form. The Hugh transform takes a binary edge map as input and tries to find straight lines where the edges are positioned. The Hough transform works by transforming each edge point in an edge map into all conceivable lines that could pass through it. Many image processing techniques include automatic circle identification as a key component.

The Hugh transform has long been used to locate circular objects in photographs, but more recent approaches that employ heuristic optimization techniques have emerged. Every point in the transform space is used as an accumulator to detect or identify a line described by in the transform space, which has two dimensions. Every point along the image's recognized edges contributes to the accumulators.

3.12 Normalization

It helps in obtaining the invariance of image/ iris size, position and different angle of dilations. Image normalization is a technique for putting several photographs into a common statistical distribution in terms of size and pixel values, which is commonly used in the compilation of data sets for artificial intelligence (AI). However, a single image can also be normalized.

The point from normalization comes behind calibrating the different pixels intensities into a normal distribution which makes the image looks better for the visualizer. Main purpose of normalization is to make computation efficient by reducing values between 0 to 1. Furthermore, data normalization seeks to eliminate data redundancy, which happens when many fields contain the same information. You may make a database more flexible by reducing redundancies. In this way, normalization allows you to scale and expand a database.

Benefits of image normalization:

- Reduces the amount of duplicated data.
- Ensures that data in the database is consistent.
- Database design that is more adaptable.
- Higher database security.
- Execution that is better and faster.

4. RESULT

Result of implemented matlab code using the Daughman’s Algorithm segmentation method is as following:

Step 1: **Image Acquisition**

Taking image as input

Figure 4.1 Image acquisition

Step 2: **Grey scale conversion**

Converting the image into grayscale using the function rgb2gray().

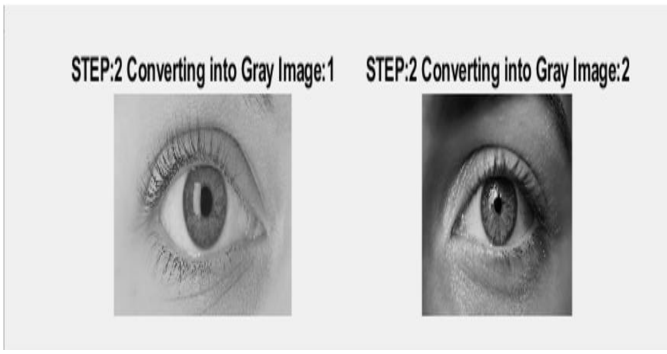

Figure 4.2 Convert into gray image

Step 3: **Subtracting the original image from grayscale image**

Here, we have used imsubtract(x,y) function to subtract the original image.

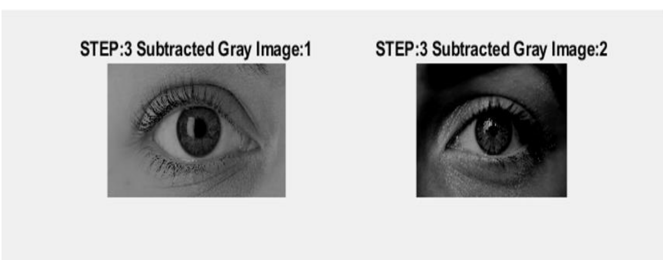

Figure 4.3 Subtract gray image

Step 4: **finding histogram of the image**

In this step, we have used imhist() function to generate the histogram of image.

imhist works with only 8 bit images. Hence, converting the image to unsigned 8 bit image and plot the histogram.

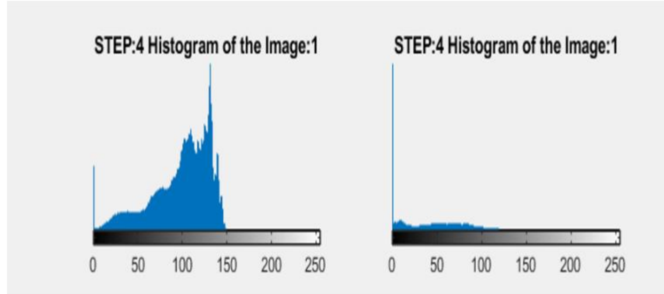

Figure 4.4 Histogram

Step 5: **Cropping of image**

imcrop() function is used in this step.

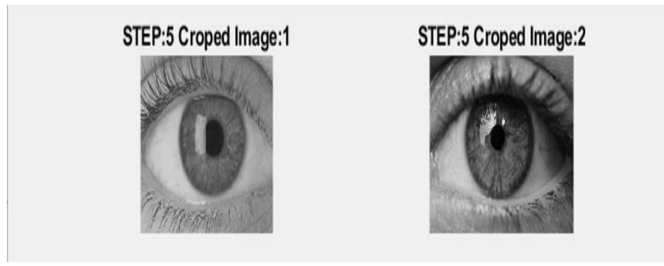

Figure 4.5 Resized image

Step 6: **resizing of image**

imresize() function is used in this step.

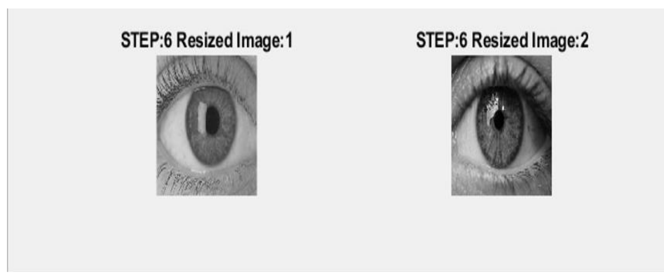

Figure 4.6 Resized image

Step 7: **Image smoothing using gaussian filter**

When you blur an image with a Gaussian function, you get a Gaussian blur (named after mathematician and scientist Carl Friedrich Gauss). It's a common graphics software effect for reducing visual noise and detail.

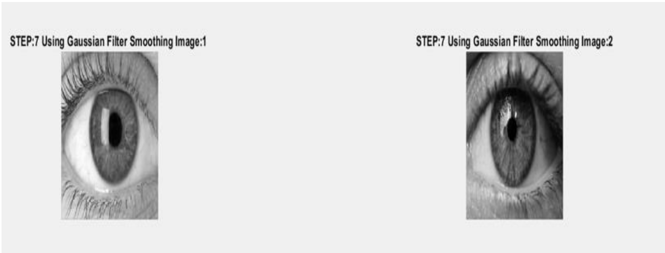

Figure 4.7 Smoothing using Gaussian Filter

Step 8: **Image segmentation process**

A multi-stage edge detector, the Canny filter is, to compute the gradient intensity, it employs a filter based on a Gaussian's derivative.

Figure 4.8 Edge detection using Canny Filter

Step 9: **Sobel edge detection**

For edge detection, the Sobel filter is used. It calculates the image intensity gradient at each pixel inside the image.

Figure 4.9 Edge detection using Sobel Filter

Step 10: **Gamma adjustment**

By taking advantage of the non-linear way in which humans perceive light and color, gamma encoding of images is used to maximize the use of bits when encoding an image or bandwidth utilized to transmit an image.

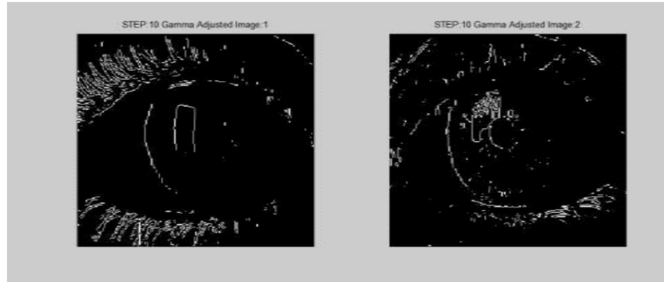

Figure 4.10 Gamma Adjustment

Step 11: **Hough transformation**

The Hough reconstruct takes a paired edge graph as input and tries to find direct route where the edges are arranged. The Hough remodel works by reconstructing each edge point in an edge map into all reasonable lines that keep penetrate it.

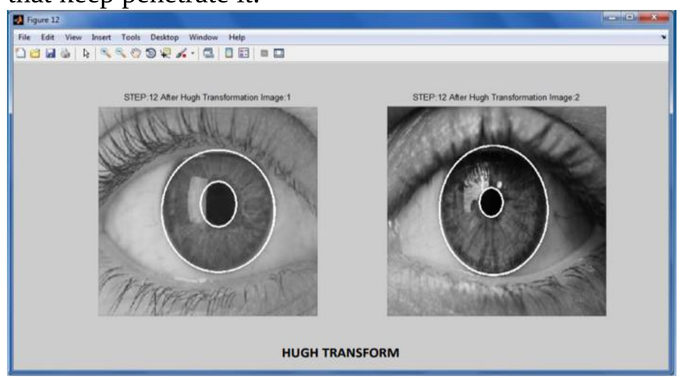

Figure 4.11 Hugh Transformation

Step 12: **Prediction of iris**

This step will detect, whether both the iris in the images are same or not.

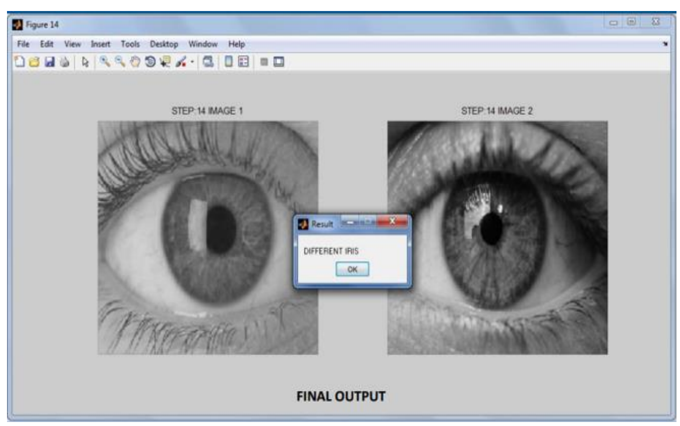

Figure 4.12 Final result

5. DISCUSSION

It was important to acquire images under the identical conditions in order to accomplish accurate iris segmentation. To make the segmentation process easier, it was vital to make sure that the image was taken accurately from the start, ensuring that there were no items that partially or totally impede the iris, making the detection task easier. One of the main issues raised by the databases was that most iris photographs did not appear full, with the iris frequently being partially obscured by another item, such as the eyelid, eyelashes, hair, or the wearing of glasses.

As images were captured by sensors under settings of varying illumination and distance, each image required its own transformation of Hughcriteria for circumference detection.

The interior and exterior parts of the iris were segmented using two circumferences. The Hugh transform was employed to complete the external circumference of the commonly used pictures, which was not complete. Solely this cases, the internal circumference was complete in the data-bases employed; nonetheless, the key challenge was determining the proper contrast to distinguish the pupil from the iris, as there was a difficult-to-distinguish contrast.

Advantages of Hugh Transformation:

- Pixels on a single line do not have to be contiguous in the Hough transform.
- When trying to detect lines with short breaks in them due to noise, or when objects are partially obscured, Hugh transform can be quite useful.
- To detect the presence of a circular shape in a given image, the Hugh transform can be used.

Disadvantages of Hugh Transformation:

- When objects are aligned by accident, Hugh transform might produce deceptive results.
- Instead of finite lines with defined end points, detected lines are endless lines described by their (m,c) values in Hugh transform.

6. CONCLUSION

Because of its circular structure, the Hugh transform can be utilized to identify iris. The detection and segmentation of the iris is formed easier by the definition and correct execution of a picture process procedure. It's robust to seek out an iris image victimization this technique thanks to the gap and look of circular objects among it. For the proper detection of the iris and to forestall showing false positives within the identification, the best thresholds for binarization, the clever technique, and therefore the Hough remodel should all be determined properly. the gap, the device (sensor), the illumination, the setting, the standard, and therefore the area within which the image is captured square measure all aspects that create precise identification tough to attain.

The task of the next stages will be easier by establishing a systematic method for iris identification, which will begin with the acquisition phase if the criteria are set and applied to be regarded a clean image. The method that will be utilized to produce segmentation must take into account the conditions in which the photos were captured as well as the databases that will be utilized. As a result, each stage of the process will complete its task and contribute to the improvement of the image by removing items that are irrelevant to the segmentation process.

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