MODERN MEDICINE AND PRACTICE
https://inovatus.es/index.php/ejmmp
EUROPEAN JOURNAL OF MODERN MEDICINE AND PRACTICE
Vol. 4 No. 9 (Sep - 2024) EJMMP ISSN: 2795-921X

IMAGE ENHANCEMENT AND FEATURE EXTRACTION FOR IRIS RECOGNITION

Qaysar Salam Nayef Ali, Hind Aziz Hussein Ali,
Ibrahim Dhaidan Jassim, Shaimaa Owaid Awad
Unlversity of Fallujah College of Applied Science Dept. of Medical Physics

Abstract: Iris recognition systems have been proposed by many researchers using different feature extraction techniques to obtain accurate and reliable biometric authentication. In this research, a technique for extracting statistical features based on the correlation between adjacent pixels was proposed and implemented. Iris fingerprint technology has been used in the medical field.

Iris fingerprint technology can be used to identify and verify a patient's identity. Iris recognition can help ensure the accuracy of patient records, and by scanning a patient's iris, hospitals can quickly and accurately identify patients, reducing the risk of medical errors and ensuring patient safety. Iris fingerprint technology can also be used to control access to sensitive areas within a hospital, such as medication storage rooms or operating rooms, helping to prevent unauthorized access and theft.

Additionally, iris fingerprint technology can also be integrated with electronic health records (EHR) systems. Allowing seamless and secure access to patient information by authorized healthcare providers.

The use of iris fingerprint technology in hospitals can improve patient safety, enhance security, and simplify access to medical records, which ultimately has the potential to improve safety and efficiency in the medical field and improve the quality of care for patients.

1. Introduction

Among the various biometric authentication systems such as Fingerprint, Face, and Iris recognition systems, the Iris recognition system has been proven as the most accurate one [1]. This system gives better performance because of its permanency in nature. The chance of a change in its form due to aging or other deformities in the iris portion of the image is very less.

Unlike other biometric recognition systems, Iris recognition systems are non-intrusive, that is it does not require a point of contact for scanning its biometric input.



Figure(1.1): Iris recognition systems.

It can capture the image from a long distance using a sophisticated camera, which will provide good quality images without much distortion. This made the Iris recognition system to be popular than other biometric recognition systems.

The various steps involved in the Iris recognition systems are preprocessing feature extraction and image matching input show the figure(1.1). Preprocessing involves filtering of the noise and occlusions due to eyelid and pupil elements in the iris portion of the image; edge detection of image; iris localization for detecting pupil's and iris' radius and image normalization to distinguish iris from other portions of the image. Features will be extracted using various image processing techniques such as wavelet transform and Haar basis filter [2].

Using these methods, Iris images can be converted into Iris Codes. Matching of Iris images is performed using techniques such as Hamming distance and Euclidian distance. Comparison of Iris Codes using binary bit representation requires less memory space for storage and hence authentication system based on Iris Code is faster.

The goal of our research project is :

- To develop a medical code using algorithms.
- Through this technology, we can facilitate secure access to medical records and accurately determine the patient’s identity.

The problem that can be solved through this project :

- Hospitals can identify patients quickly and accurately, reducing the risk of medical errors and ensuring patient safety.
- Iris fingerprint technology can also be used to control access to sensitive areas within a hospital, such as medication storage rooms or operating theatres, helping to prevent unauthorized access and theft.

1.2 Literature review

Papers about iris recognition are crucial for disseminating advancements and methodologies within the field, fostering a deeper understanding among researchers.

Various review papers about the Iris recognition process and methods proposed by various researchers in different stages of Iris recognition systems are given below:

In 2001, Ratha et al. proposed a new idea known as cancellable biometric by which an intentional distortion would be made on the original iris pattern using a revocable and non-invertible transformation. A hacker can access the iris patterns stored in the database which then can be modified [3].

In 2006, Elsherief et al . analyzed the operations of different stages of the Iris recognition system such as preprocessing techniques like iris imaging and iris detection, feature extraction and recognition, etc. Iris boundaries were found out by forming edge mapping using edge detection techniques such as the canny edge detection technique. Houman transform was applied to get the inner and outer circular boundaries of the iris portion. Linear Hough man transform was applied to detect lower and upper eyelids [4].

In 2008, Zuo et al. proposed another efficient method for implementing cancellable techniques by which four noninvertible and revocable transformations were used. Random circular shifting and addition were used for the first two transformations and random noise patterns were introduced in the last transformation method. This method shows low performance because the feature vector formed due to the transformation represents the combination of properties of good and bad regions of an image[5].

In 2009, He et al. proposed a locating Iris boundary. The techniques like integral differential operator, binary edge map using edge detectors which used Hough

transform, using Gabor filter, using intensity threshold, SVM classifier and applying active contour to iris boundaries are used for segmentation and localizing boundaries of iris images for extracting iris region from an image, effectively [6].

In 2016, Thomas et al. proposed an accurate technique known as RANSAC (Random Sample Consensus) which would be used for identifying boundaries by locating the inner iris boundary with pupil and outer boundary. The image would be localized by fitting an ellipse over the iris boundaries[7].

In 2016, Sun et al. suggested that a new method is required to develop a system that can capture a high-quality image in a larger volume from a long distance. Iris portion of the image might contain elements of pupil or sclera. Hence it would be essential to separate iris image from this by a process known as segmentation[8].

In 2016, Pillai et al. proposed a new method of enhancing the security of the Iris recognition system. They generated a cancellable Iris template to prevent the compromise of original Iris information. The original iris pattern would be transformed into a new form by applying a random projection matrix to the iris vector [9].

A security system using Cryptographic techniques [10] by Hao et al**(2006)**, cancellable iris biometrics using error correcting codes by Kamade et al. **(2009)** are few among the popular systems used to address vulnerabilities [11].

2.1 The iris

The iris is part of the uveal tract, which also includes the ciliary body and the choroid. Its function is to control the amount of light that reaches the retina. Due to its heavy pigmentation, light can only pass through the iris via the pupil, which contracts and dilates according to the amount of available light. Irises are pigmented with melanin and lipofuscin [17].

Iris dimensions vary slightly between individuals, but on average it is 12 mm in diameter [Forrester et al. 2001]. Its shape is conical with the pupillary margin located

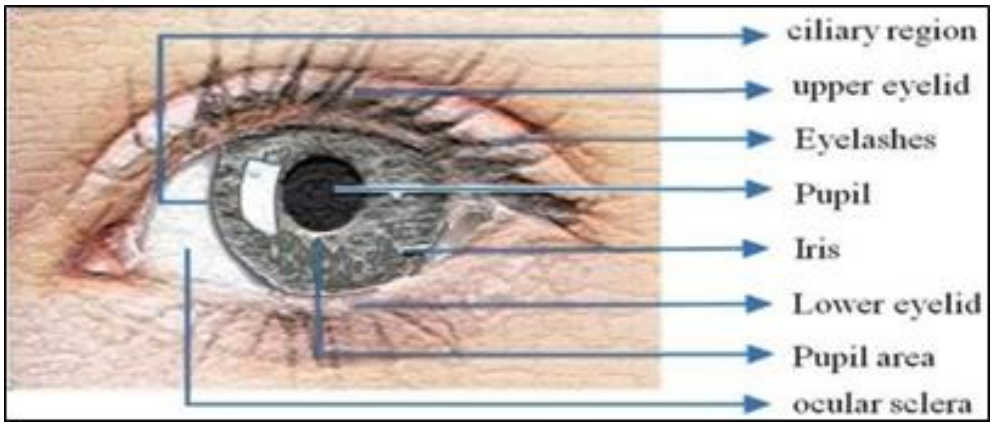


Figure(2.1)The Iris [18]

more anteriorly than the root. The anterior surface is divided into the ciliary zone and the pupil zone by a thickened region called the collarets the show figure(2.1).

2.1.1 Iris Structure

The iris is a circular, colored structure that sits in front of the lens within the coronal plane towards the front of the eye. The iris consists of two layers: the front pigmented fibro vascular layer known as a stroma and, beneath the stroma, pigmented epithelial cells. The stroma is connected to a sphincter muscle (sphincter pupillae), which contracts the pupil in a circular motion, and a set of dilator muscles (dilator pupillae), which pull the iris radially to enlarge the pupil, pulling it in folds (figure 2.2).

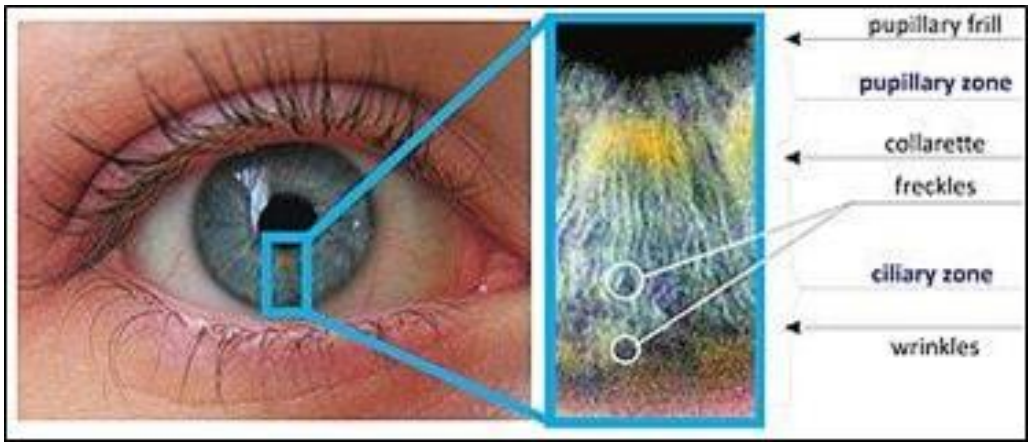


Figure(2.2): Iris structure[19]

The sphincter pupillae is the opposing muscle of the dilator pupillae. The pupil's diameter, and thus the inner border of the iris, changes size when constricting or dilating. The outer border of the iris does not change size. The constricting muscle is located on the inner border.

The back surface is covered by a heavily pigmented epithelial layer that is two cells thick (the iris pigment epithelium), but the front surface has no epithelium. This anterior surface projects as the dilator muscles. The high pigment content blocks light from passing through the iris to the retina, restricting it to the pupil. The outer edge of the iris, known as the root, is attached to the sclera and the anterior ciliary body[20].

The iris and ciliary body together are known as the anterior uvea. Just in front of the root of the iris is the region referred to as the trabecular meshwork, through which the aqueous humour constantly drains out of the eye, with the result that diseases of the iris often have important effects on intraocular pressure and indirectly on vision. The iris along with the anterior ciliary body provide a secondary pathway for aqueous humour to drain from the eye (figure 2.3).



Figure(2.3)Iris region[21]

The iris is divided into two major regions:

1. The pupillary zone is the inner region whose edge forms the boundary of the pupil
2. The ciliary zone is the rest of the iris that extends to its origin at the ciliary body.

3.1 Methodology

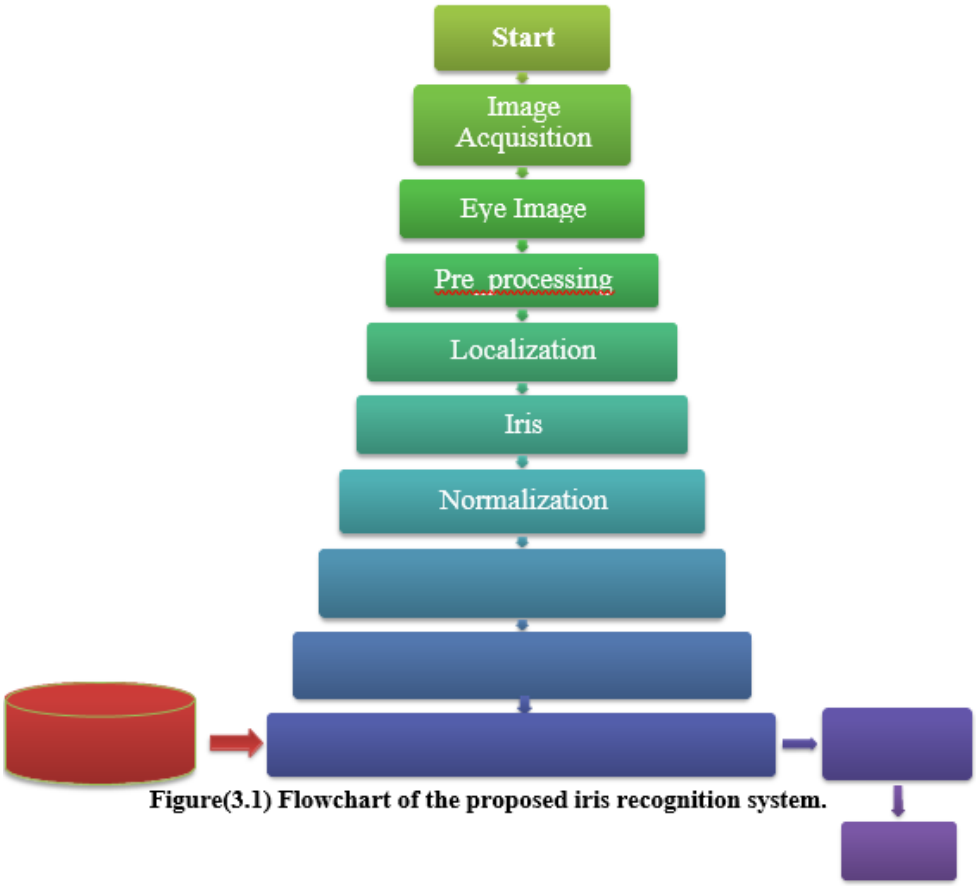
The system is to be composed of a number of sub-systems, which correspond to each stage of iris recognition. These stages are:

- Image acquisition-capturing eye image
- Segmentation -locating the iris region in an eye image
- Normalization-creating a dimensionally consistence representation of the iris region
- Feature encoding - creating a template containing only the most discriminating features of the iris.

The input to the system will be an eye image, and the output will be an iris template, which will provide a mathematical representation of the iris region.

3.2 Iris Recognition System

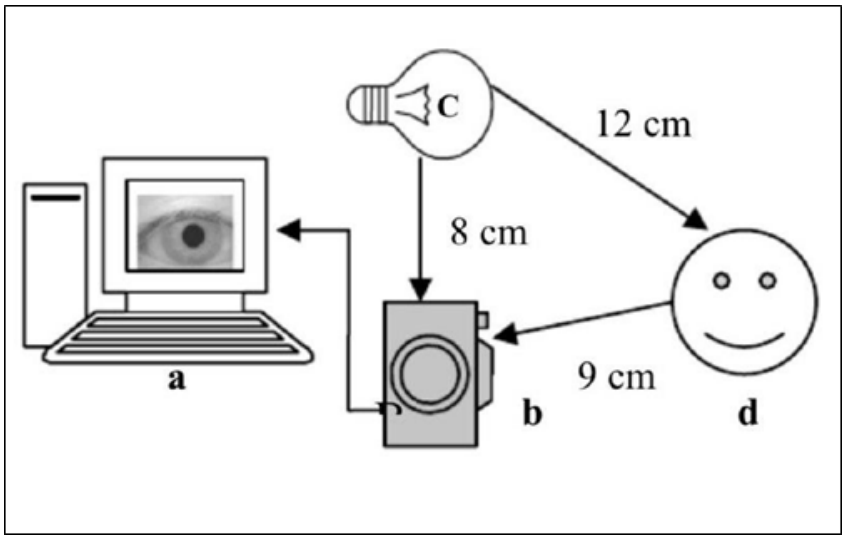
Iris recognition system mainly consists of four steps as shown in(Figure 3.1).The general block diagram of iris recognition system :



Figure(3.1) Flowchart of the proposed iris recognition system.

3.1.1 Image Acquisitioning

Image acquisition is the first step of iris recognition process. Since every person has different size and color of iris, image acquisition step is being very complex process. Capturing clear iris images is very difficult with the standard CCD cameras in different circumstances. Generally, iris image acquisition distance is 2 feet to 3 feet in one or two seconds show the (Figure3.2) .



Figure(3.2) Image acquisition System

Sometimes the acquisition step yields different results for the same person because of the different lighting effects, or not keeping the capturing distance [49].The size of the diameter of the iris is approximately 11 mm and its color is varying base on the nationalities of the people. Image acquisition plays a critical role in iris recognition due to the best matching performance directly proportional to images that have been taken good show the **(**Figure3.3). Poor imaging implies high unlikeness for the intra-class comparisons [50]. In contrast, inter class scores are independent of image quality [51].



Figure(3.3) Image acquisition 0f the patient's eye.

3.1.2 Pre-processing

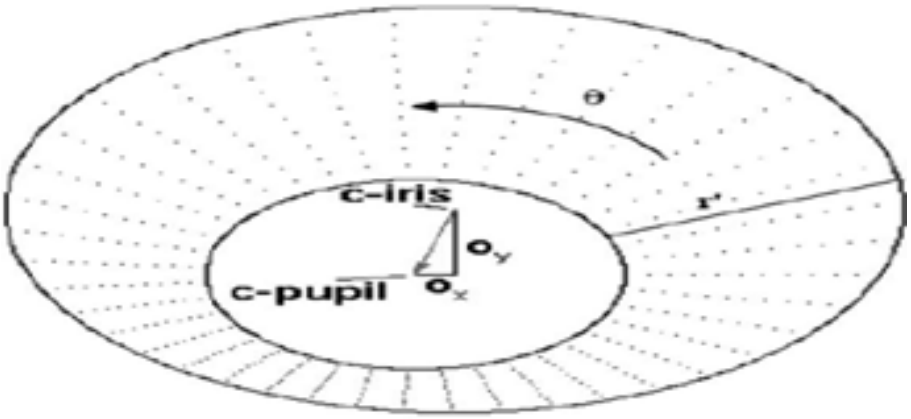
Iris pre-processing includes the localization, segmentation and normalization stages. These are very important for recognition success rate. Iris localization determined the inner and outer boundaries of the iris region in order to use in the feature analyzing process. Localization can be considered the one of the most

difficult part in the iris identification system [52]. Segmentation aims to accurately localize iris boundaries without noise (eyelids, eyelashes, reflection, occlusion). Normalization aims to get a rectangular iris texture by mapping the annular iris information between pupillary and limbic boundaries of the iris region that is firstly has been proposed by John Daugman by using polar coordinates [54]. Mistakes in the segmentation process cannot be recovered at the other stages. Masking in the step is also very important. Segmentation problems indicate false rejections. There are different segmentation methods, such as edge points detection and curve fitting, [53] but mainly the ones that are used are the Integra differential operator and Hough Transform [54].

3.3.4 Image Normalization

Once the iris region is segmented, the next stage is to normalize this part, to enable generation of the iris code and their comparisons. Since variations in the eye, like optical size of the iris, position of pupil in the iris, and the iris orientation change person to person, it is required to normalize the iris image, so that the representation is common to all, with similar dimensions[59].

Normalization process involves unwrapping the iris and converting it into its polar equivalent (Figure3.9) . It is done using Daugman's Rubber sheet model. The center of the pupil is considered as the reference point and a Remapping formula is used to convert the points on the Cartesian scale to the polar scale.



Figure(3.9) Normalization process

The radial resolution was set to 100 and the angular resolution to 2400 pixels. For every pixel in the iris, an equivalent position is found out on polar axes[59].The normalized image was then interpolated into the size of the original image, by using the interp2 function. The parts in The normalized image which yield a NaN, are divided by the sum to get a normalized value figure(3.10) [59][60].

3.3.5 Feature Extraction

Feature vector extraction aims to generate an optimum representation of characteristic of the iris texture code in order to get best performance for the matching step. The generated features are registered to the system database. Binary and real valued representations are used for the feature extraction till now. John Daugman has used binary feature vectors in his iris code and it supports the matching process by quantizing intermediate features. J. Daugman's iris code algorithm used 2D Gabor wavelets. Phase information has been used and quantized by using two bits encoding the phase quadrant. The most widely accepted way of identifying the phase information is the assignment of the phase of each pixel according to the quadrant where it belongs. The whole phase space is quantized in four levels. The four quadrants are assigned values of "11", "01", "00", "10" for the first, second, third and fourth quadrant, respectively [61]. These values assigned constitute the template of an iris and these templates are used to compare different eyes. The choice of these values has been done in a relatively clever way that matches very well with the statistical method that is used to quantify the similarity between the irises. Statistically speaking, when one uses a XOR operator, there is a 50% difference between any subsequent quadrant and a 100% difference between any two opposite quadrants.

3.3.6 Pattern Matching

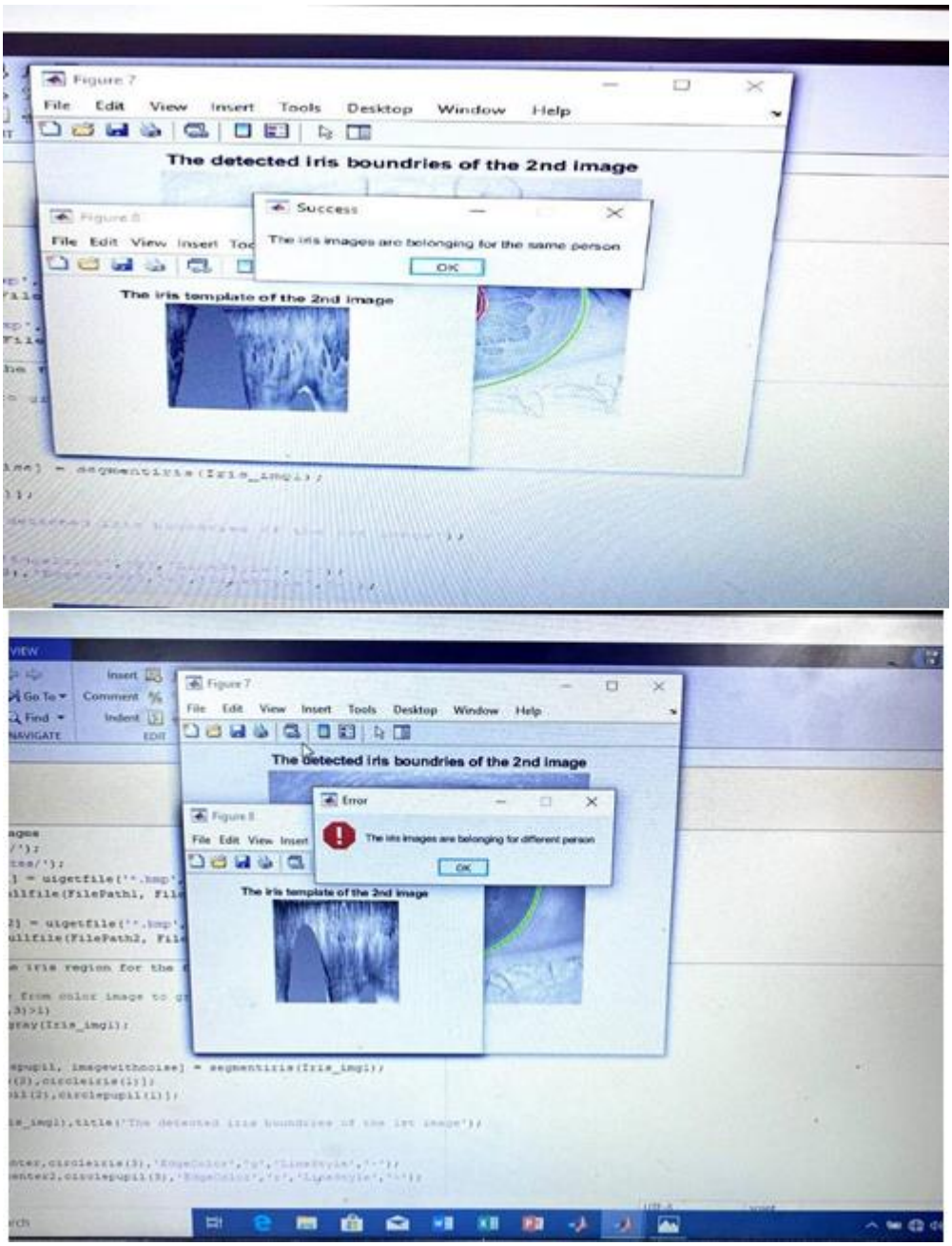
Recognition process is carried out using template matching. In template matching, user iris template is compared with the templates from the database using matching metric. The matching metric gives different range of values when a given iris template is compared with the other stored templates. Based upon these range of values, a decision is taken about the identity of a person figure(3.11), i.e., the person is who they claim to be?

Hamming distance is chosen as a metric for recognition, since bit-wise comparisons were necessary. The Hamming distance algorithm employed also incorporates noise masking, so that only significant bits are used in calculating the Hamming distance between two iris templates. Now when taking the Hamming distance,

only those bits in the iris pattern that corresponds to '0' bits in noise masks of both iris patterns will be used in the calculation.

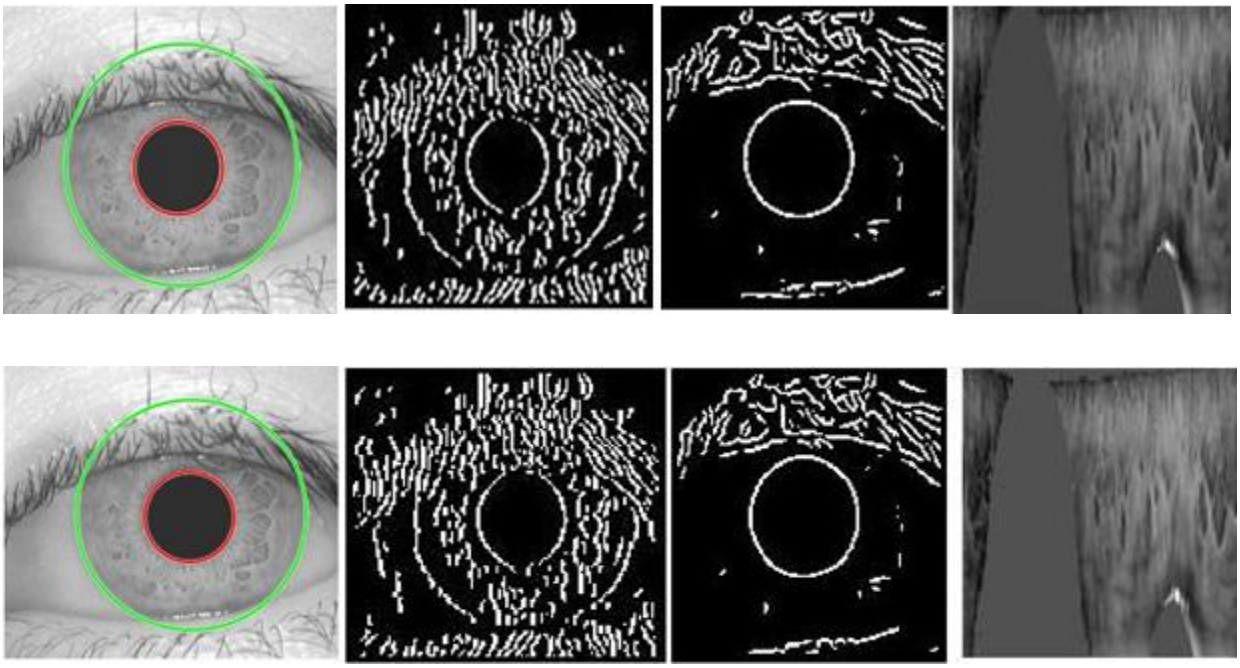
The Hamming distance will be calculated using only the bits generated from the true iris region. Although, in theory, two iris templates generated from the same iris will have a Hamming distance of 0, in practice this will not occur. Normalization is not perfect, and also there will be some noise that goes undetected, so some variation will be present when comparing two intra-class iris

templates [61]. This method is suggested by Daugman [62], and corrects for misalignments in the normalized iris pattern caused by rotational differences during imaging. From the calculated Hamming distance values, only the lowest is taken, since this corresponds to the best match between two templates.

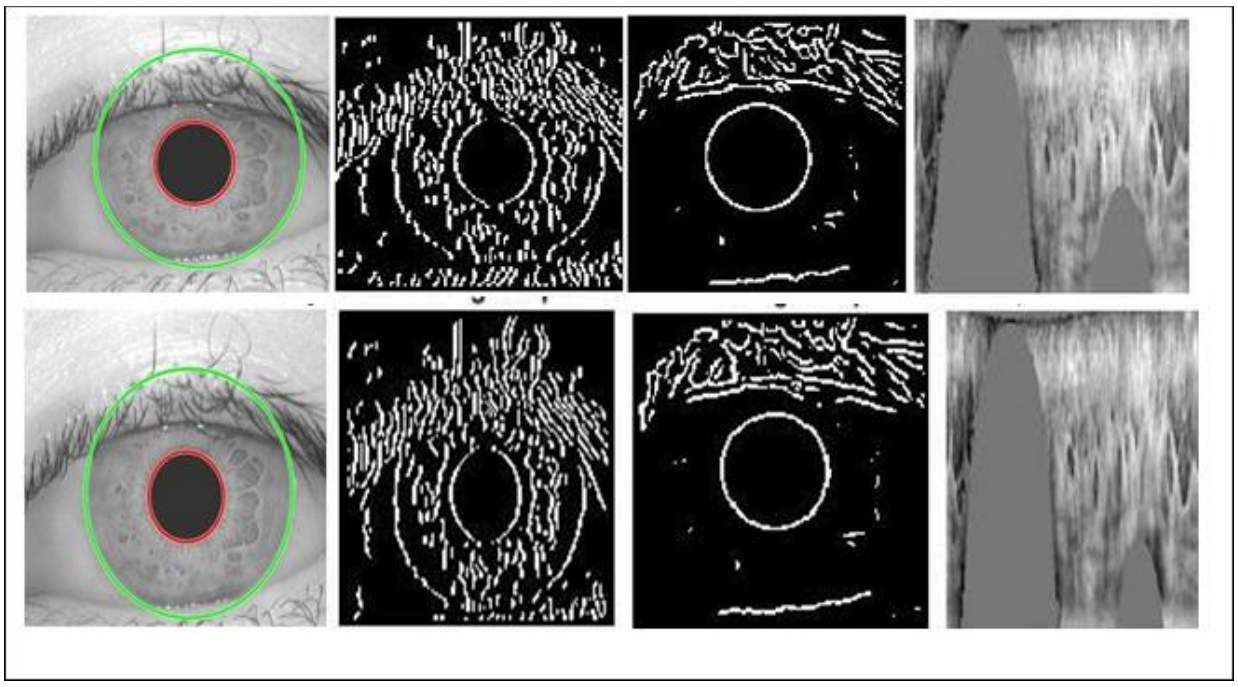


Figure(3.11)Pattern Matching results

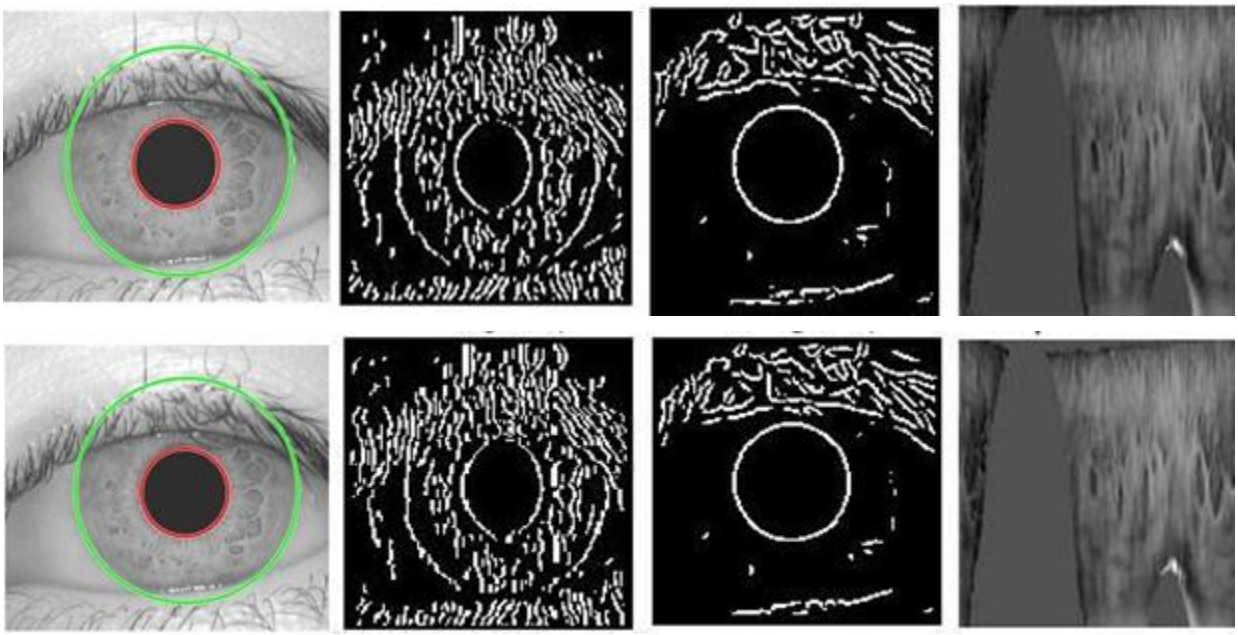
Case no:1



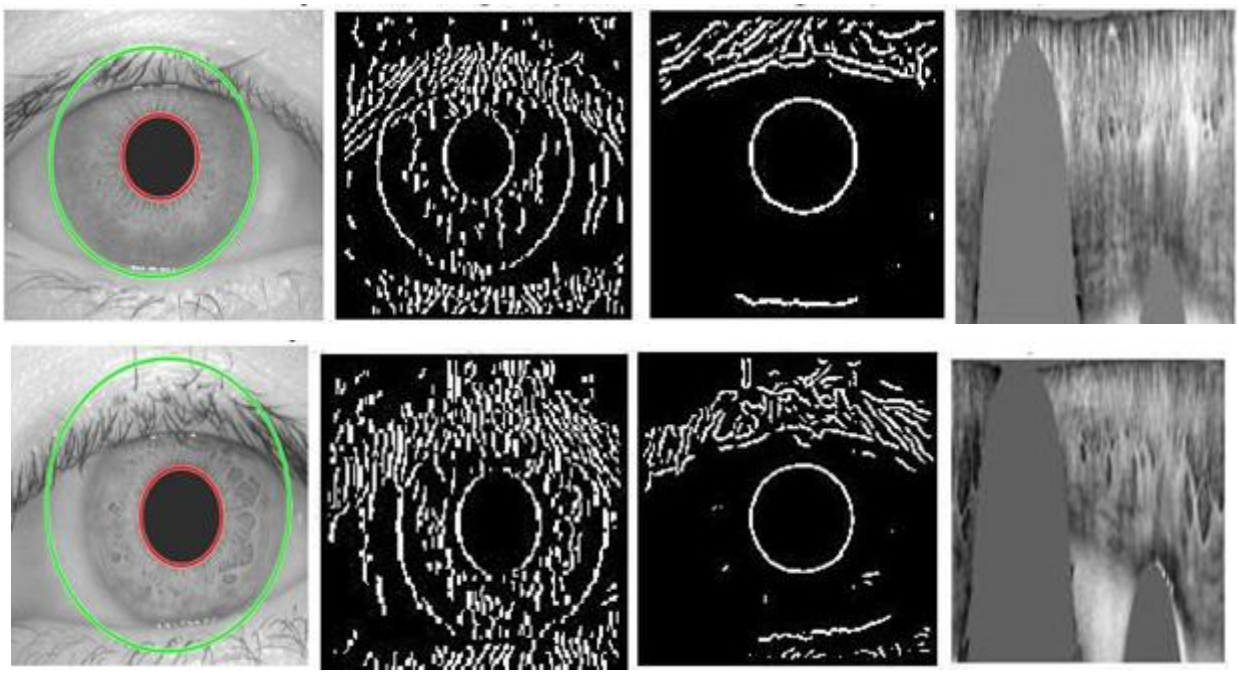
Case no:2



Case no:3



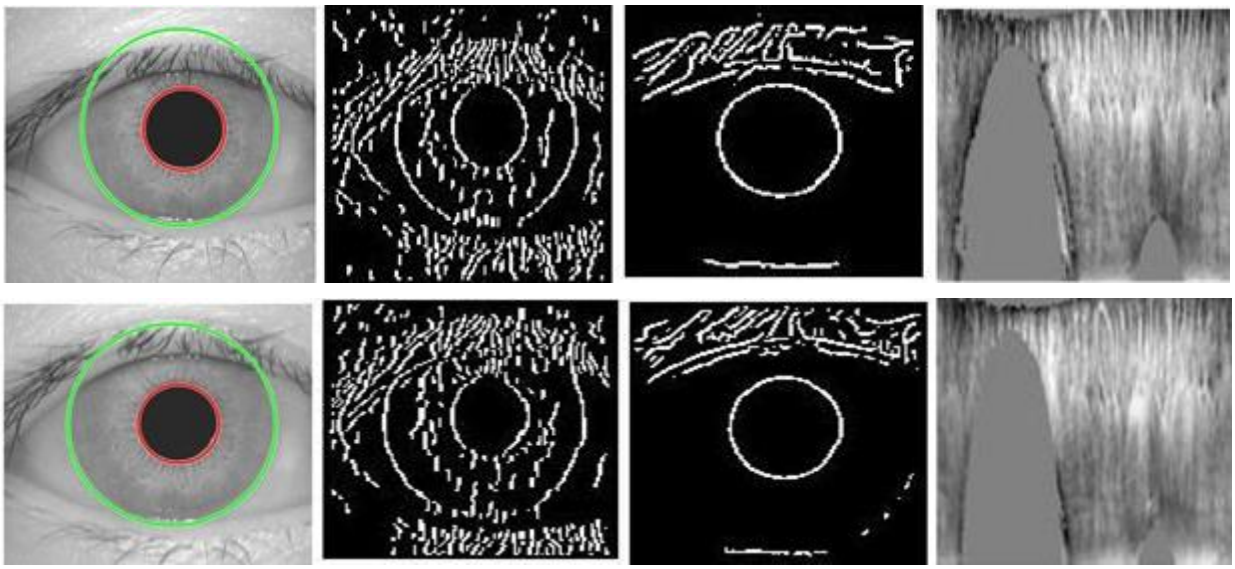
Case no:4



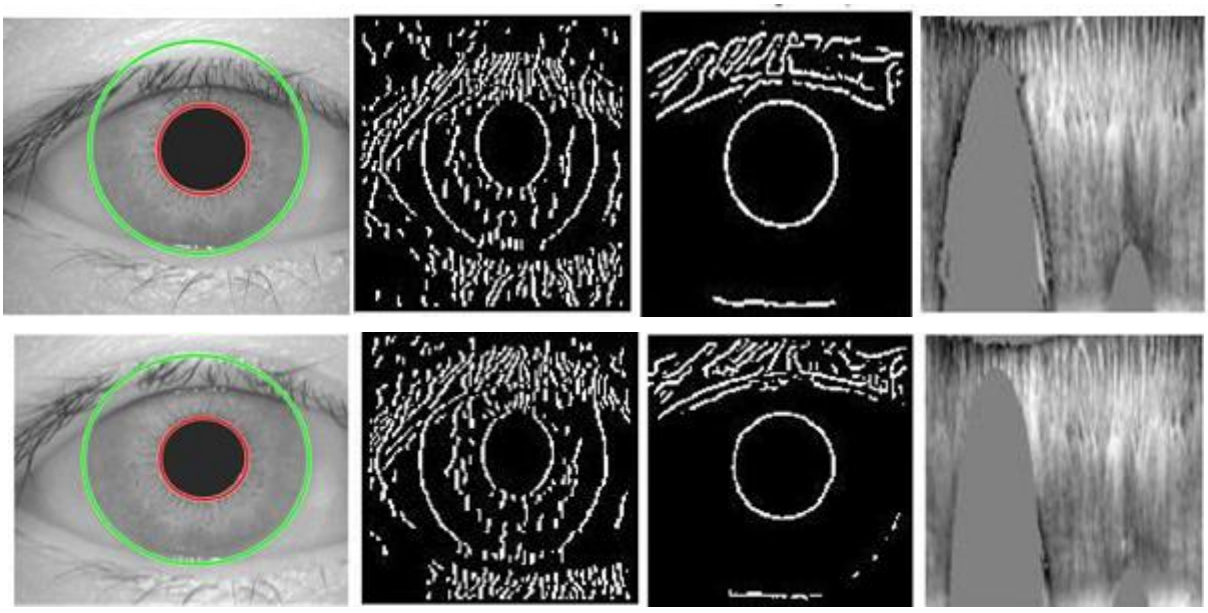
Case no:5



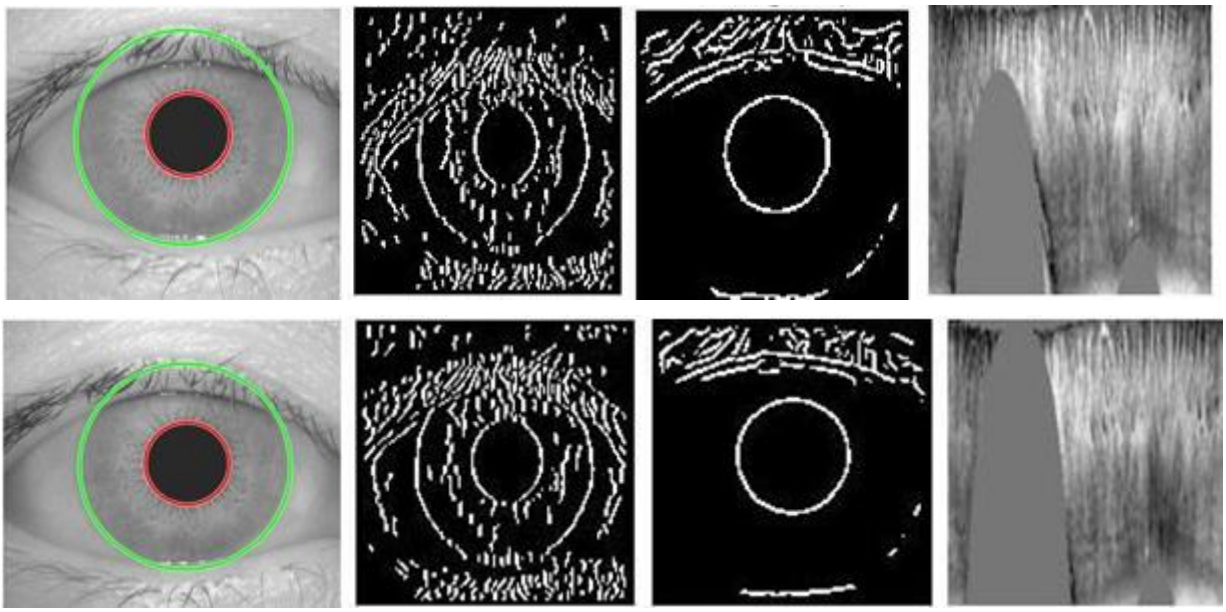
Case no:6



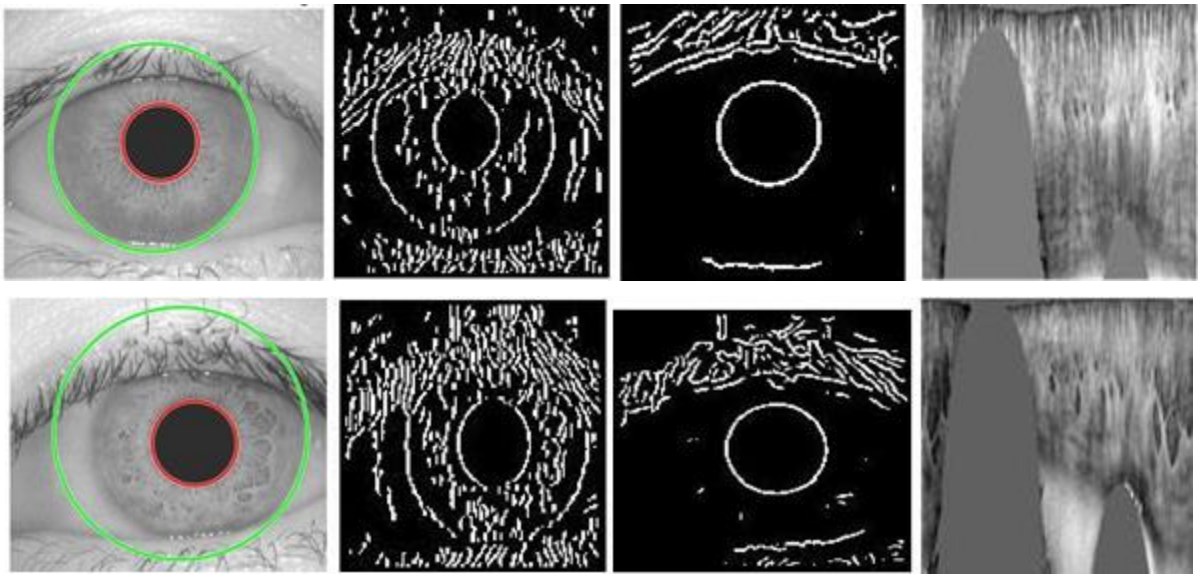
Case no:7



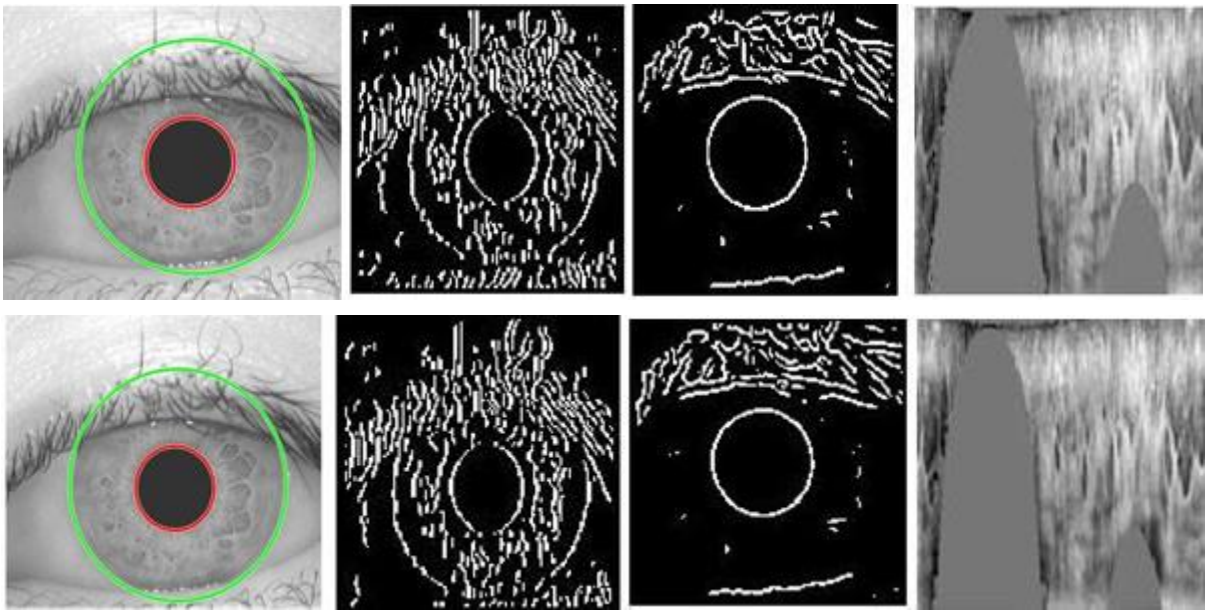
Case no:8



Case no:9



Case no:10



We conclude that if the case contains two images of the same person, the result will be matching as in (case 1).

However, if the case contains two images of two different persons , the result will not be matching, as in (case 7).

The table below shows the results of the images on which the iris recognition technique was applied to identify patients show the(table 1).

Case no:1	**Matching**
Case no:2	**Matching**
Case no:3	**Not matching**
Case no:4	**Matching**
Case no:5	**Matching**
Case no:6	**Matching**
Case no:7	**Not matching**
Case no:8	**Not matching**
Case no:9	**Matching**
Case no:10	**Matching**

Table 1: The results of Iris recognition technique.

Conclusion

Accurate and positive personal identification is possible today using the human iris. This unique and complex device, which has more dimensions (measures) of variation than any other biometric trait currently in use, remains stable throughout the lifespan and is readily available for non-intrusive sampling. The process uses simple, non-risky video technology to take images of the iris, digitize the features, and generate a 512-byte code, which is then compared to an entire database in less than two seconds.

This research was developed. We used scanning using a fundus imaging device, which is connected to a (CCD) camera. Several pictures are taken of the patient's eye. It is possible to take pictures of both eyes or one eye, which takes less than two or three minutes to take, and this picture is entered into the Matlab 2020 program and was completed. Using techniques to process digital images of pixels and convert them into a digital format using ones and zeros so that they can be stored.

In this work, fifty photos were taken of ten patients aged between 19-64 years, and this technique was applied to the photos, and the identification rate of these people was achieved at 99.4% . The input image is converted from color images to grayscale images for easy segmentation and converted to binary to facilitate the representation of error graphics and ease of applying algorithms using the algorithm extracted from these algorithms suggested by the local information of each eye image using image processing techniques such as transforming powerful signal tools for signal analysis, which They will generally be used in applications for image compression, noise reduction, feature extraction, detection, recognition, and retro image enhancement. bcasic contamination for hair acquisition on the iris image, pre-processing stage for image enhancement, iris segmentation stage for the iris region of the eye image, normalization stage for converting the scratched iris into a rectangular pattern feature extraction stage for extracting iris features, and feature verification stage for selecting unique features and matching classification matching stage to find the similarities and similar images in databases. Experimental results show that algorithms can effectively outperform between different people if the similarity between learned features and fetish features is less than those already defined as the same person and used for patient identification and verification.

REFERENCES

1. N.K. Kak, R. Gupta, S. Mahajan ,"Iris recognition system" International Journal of Advanced Computer Science and Application (IJACSA) vol1no, 1 (2010)
2. S.S. Harakannanavar, V.I. Puranikmath ,"Comparative Survey of Iris Recognition" International Conference on Electrical, Communication, Computer and Optimization Techniques (ICEECCOT), 2017 IEEE (2017).

3. N.K. Ratha, J.H. Connell, R.M. Bolle ,"Enhancing security and privacy in biometrics- based authentication systems" ,IBM Syst. J., 40 (2001), pp. 614-634
4. S.M. Elsherief, M.E. Allam, M.W. Fakhr ,"Biometric Personal Identification Based on Iris Recognition", IEEE 1-4244-0272-7106-2006 (2006)
5. J. Zuo, N.K. Ratha, R.M. Connell Cancelable Iris biometric Proceeding of International Conference on Pattern Recognition (2008), pp. 1-4
6. Z. He, Z. Tan, Z. Sun, X. Qiu ,"Toward accurate and fast Iris segmentation f",or Iris biometrics IEEE Trans. Pattern Anal. Mach. Intell., 31 (9) (2009) Sept. 2009
7. T. Thomas, A. George, K.P. "Indira Devi Effective Iris recognition system", RAEREST 2016 elsevier (online) science direct
8. H. Li, Z. Sun, M. Zhang, L. Wang, L. Xiao, T. Tan . "A Brief Survey on Recent Progress in Iris Recognition", CCBR, 2014 Springer International Publishing (2014) LNCS 8833 PP288-300, 2014
9. J.K. Pillai, V.P. Patel, R. Chellappa, N.K. Ratha ."Robust and secure Iris recognition"The Book - Handbook of Iris Recognition: Chapter1, springer (2016)
10. F. Hao, R. Anderson, J. Daugman ."Combining crypto with biometrics effectively",IEEE Trans. Comput., 55 (9) (2006), pp. 1081-1088
11. S. Kanade, D. Petrovska-Delacretaz, B. Dorizzi ."Cancelable iris biometrics" and using error- correcting codes to reduce variability in biometric data Computer Vision and Pattern Recognition (2009)
12. H.A. Biu, R. Husain, A.S. Maggi ."An enhanced Iris Recognition and Authentication system", using Energy measure Sci. World J., 13 (1) (2018) pp. 1597-6343
13. D. Sadhya, B. Raman ."Generation of cancelable Iris templates via randomized bit sampling .IEEE Trans. Inf. Forensics Secur., 14 (11) (2019), pp. 2972-2986,
14. Z. Ma, et al. EmIr-auth: eye movement and iris-based portable remote authentication for Smart grid IEEE Trans. Ind. Inf., 16 (10) (2020), pp. 6597-6606
15. D. Jiang, G. Zhang, O.W. Samuel, F. Liu, H. Xiao ."Dual-factor WBAN enhanced authentication system", based on Iris and ECG descriptors ,IEEE Sensor. J., 22 (19) (2022), pp. 19000-19009
16. P. Polash, M. Monwar et al., "Human iris recognition for biometric identification," in Computer and information technology, ICCIT 2007. 10th international conference on. IEEE, pp. 1–5, 2008
17. Sarna and Sealy 1984; Delori and Pflibsen 1988; Clancy et al. 2000.
18. https://www.allaboutvision.com/eye-care/eye-anatomy/colored-part-of-eye/.
19. https://www.ncbi.nlm.nih.gov/core/lw/2.0/html/tileshop_pmc/tileshop_pmc_inline.ht ml?title=Click%20on%20image%20to%20zoom&p=PMC3&id=9044324_peerj-cs-08- 919-g001.jpg
20. "eye, human." Encyclopædia Britannica from Encyclopædia Britannica 2006 Ultimate Reference Suite DVD