ISSN 2063-5346

NEW DEVELOPMENTS IN THE IRIS AUTHENTICATION OF HUMANS FOR COMPLEX UNCONSTRAINED ENVIRONMENTS USING HYBRID METHODS IN DIGITAL IMAGE PROCESSING

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Article History: Received: 10.05.2023 Revised: 29.05.2023 Accepted: 09.06.2023

Abstract

In this research articles, new developments in the iris authentication of humans for complex unconstrained environments using hybrid methods is being presented in a nutshell with the proposition of some novel concepts which is going to be implemented as the future works.

Keyword : Identification, Authentication, Database, Image, Biometrics, Neural Network, Simulation, Matlab, LabVIEW, Pre-processing, Segmentation, Algorithm, Edge Detection, Normalization, Wavelets, Coding, Classifiers, Recognition, Iris, Hardware, Constraints, GUI, Implementation, Unconstraints, Histogram, Filter.

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DOI:10.48047/ecb/2023.12.9.120

1. Organization of the paper

Biometrics refers to the measurement and analysis of unique physical or behavioral characteristics for identification or authentication purposes. One commonly used biometric modality is iris recognition, which involves capturing and analyzing the patterns in a person's iris to verify their identity. Authentication is the process of verifying the claimed identity of an individual, while recognition is the process of identifying a person based on their biometric traits.

To perform biometric tasks such as identification and authentication, classifiers are employed. These are algorithms or models that are trained to make decisions based on input data. Simulations are often conducted using tools like Matlab or LabVIEW to test and evaluate the performance of biometric systems.

Neural networks are a type of machine learning model that can be used for biometric applications. They are designed to recognize patterns and make predictions based on input data. Databases are used to store biometric information and facilitate efficient retrieval during identification or authentication processes.

Image pre-processing techniques, such as segmentation, histogram analysis, filtering, edge detection, normalization, and wavelet analysis, are commonly applied to enhance the quality and extract relevant features from biometric images. Coding schemes are used to represent and store biometric data efficiently.

Graphical User Interfaces (GUIs) are often developed to provide user-friendly interactions with biometric systems. These interfaces allow users to provide input and receive output from the system. Biometric systems can operate under various constraints, including unconstrained scenarios where users are not restricted in their behavior, and constrained scenarios where specific conditions or requirements must be met.

Implementation of biometric systems involves both hardware and software components. Hardware includes devices such as cameras, sensors, and biometric scanners, while software includes the algorithms, models, and databases necessary to process and analyze biometric data.

To start with, the flow of the items presented in this paper is being depicted here in this section. Section II gives a brief introduction about the work done. Section III gives info about the literature survey or the review of the literatures. The problem statement and definition is depicted in section IV. The objectives of the research work is presented in section V followed by the scope of the research work in section VI. The section VII gives the outcome of the research work, whereas the section VIII gives the details related to the proposed methodology. Finally, the conclusions are presented at the end in section XI followed by the exhaustive list of references.

Fig. 1 : A typical iris scanning device

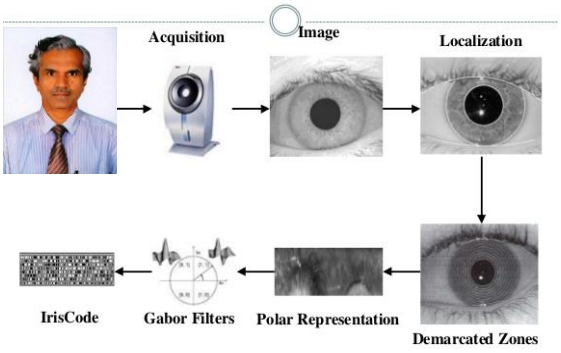

Fig. 2 : How a typical Iris Recognition System works, say using the Gabor filtering concepts

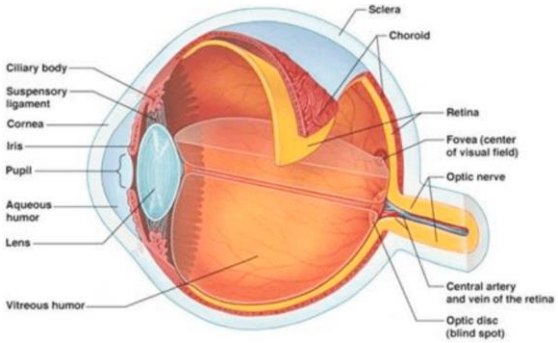

Fig. 3 : The structure of the human eye

2. Introduction

Biometrics, an essential concept in human identification, involves the use of various methods to recognize individuals. In today's world, biometrics plays a crucial role in ensuring security within organizations and accurately identifying individuals. In the current scenario, i.e., a larger role is being played by the bio-metrics in the modern 21st century automation era in this world & lot of attention is being given to it as it is finding a lot of impotence in the security issues in the various sectors. The word, 'biometric' is a beautifully coined word w.r.t. the human beings as it is bio-sapiens and makes use of the investigation of the data which is taken from the human beings (people), i.e., one of a kind physical or behavioral qualities/attributes of people to remember them.

Since biometrics is amazingly hard to manufacture and can't be overlooked or stolen, biometric confirmation offers an advantageous, exact, imperative and high secure option for a person, which makes it has points of interest over conventional cryptography-based verification plans. There exists a large number of biometric identification methodologies in the world, to name a few of them : finger prints, voice, speech, signature, keystroke, palm, thumb, retina, face, iris, password, RFID, swipe card, etc... In this computerized world in the current scenario, these unique identification techniques has gained a lot of prominence because of its uniqueness, non-invasiveness, secured approach of authentication with unique identification, no stealing and stability of the human patterns as a result of which iris was chosen as one of the recognition parameter in our biometric identification, that too under unconstrained environments. One main reason why the iris was chosen as the parameter for our research work was - it is very rare to find two irises which are similar and it will be unique for a particular person.

3. Literature Survey

Over the past decade, significant research and development efforts have been dedicated to iris recognition methods. Recent implementations have demonstrated highly reliable recognition rates in controlled environments. Previous research in iris recognition primarily focused on high-quality iris images. It was widely acknowledged that image quality directly influenced the performance of iris detection. However, iris detection systems that operate under less constrained parameters, such as long-distance capture or capturing of moving images, often suffer from issues related to resolution, brightness, and contrast, which consequently degrade iris performance during analysis and detection. These suboptimal iris images, characterized by problems such as acquisition angle, occlusion, pupil dilation, image blur, and low contrast, are referred to as non-ideal iris images.

The majority of previous works [1]-[30] in the field of iris biometric recognition focused on secure authentication systems under constrained environments. These studies typically required specific conditions, such as the camera pointing directly at the eye, the subject looking directly at the camera, no parallax, fully open eyes for iris capture, and good illumination during image acquisition. However, only a few studies [1]-[30] have addressed iris recognition in unconstrained environments, which is the primary focus of our research work. It is important to note

that algorithms developed and validated in constrained environments may not perform optimally in unconstrained scenarios. Therefore, investigating iris recognition systems specifically designed for unconstrained environments is crucial.

It is important to acknowledge that the development of Iris Recognition Systems for unconstrained environments presents numerous challenges and constraints. Previous works by various authors [1]-[30] highlighted several disadvantages, including the need for high computational resources to achieve accuracy, longer execution times, significant storage requirements for secure authentication, and the inability to handle images with disturbances or unwanted objects. Some researchers have focused on enhancing system performance and accuracy through high-speed computations. Our research work aims to address these drawbacks by developing algorithms that will be verified through simulations conducted in the Matlab and LabVIEW environments (software implementation), along with potential hardware implementation..

4. Problem definition & motivation

In the current digital era, the government has mandated the use of biometrics in various aspects of life, such as UID-Aadhar, fingerprint recognition, and PAN cards. However, each biometric method has its limitations and drawbacks. After carefully studying and evaluating different biometric methodologies, we have concluded that iris recognition offers numerous advantages, making it the most suitable method for human identification. The government's emphasis on implementing biometrics across sectors has further motivated us to conduct research in the field of iris biometrics. Given the widespread application of iris recognition in today's automated digital world, we have identified the need for new developments in iris authentication for complex and unconstrained environments. With great enthusiasm, we have conducted an extensive survey and proposed software algorithms in Matlab/LabVIEW to address this research problem. Our research work focuses on the development of hybrid methods for robust iris authentication in complex and unconstrained scenarios..

In our research, we aim to overcome the limitations and challenges associated with biometric identification in complex and unconstrained environments. These environments can include situations where lighting conditions are poor, there are variations in capturing angles, occlusions, and other factors that may affect the accuracy of biometric systems. To address these challenges, we have developed hybrid methods that combine multiple techniques to enhance the performance of iris authentication. These methods leverage the unique features and characteristics of the iris, such as its distinct patterns and stability over time.

Our software algorithms implemented in Matlab and LabVIEW allow for efficient and accurate recognition of individuals based on their iris patterns. We have designed these algorithms to handle real-time scenarios, ensuring fast and reliable identification even in challenging environments. By focusing on the iris as a biometric modality, we leverage its advantages, such as its uniqueness, stability, and non-intrusiveness. This makes it a suitable choice for various applications, including access control, identity verification, and secure authentication in sectors like banking, healthcare, government, and more. Through our research, we aim to contribute to the development of advanced iris authentication systems that can provide robust and reliable identification in complex and unconstrained environments. Our work has the potential to enhance security, improve efficiency, and streamline processes across various sectors where biometric identification is crucial.

5. Objective of the research work

The primary objectives of our research work are centered around the development of innovative and efficient bio-medical image processing algorithms in the Matlab and LabVIEW environments for biometric identification using the iris region of the human eye, particularly in unconstrained environments. One of our key objectives is to address the security and recognition challenges faced in existing biometric authentication systems by designing high-speed and efficient algorithms. We aim to overcome limitations such as computation time, storage requirements, and susceptibility to disturbances in the captured images. By developing advanced algorithms, we strive to improve the overall performance and accuracy of biometric identification systems.

Additionally, we aim to create an automated graphical user interface (GUI) system that can effectively handle diverse types of human eyes. This GUI system will facilitate seamless interaction and compatibility with different individuals, ensuring reliable and user-friendly biometric identification processes. Another important objective is to enhance the performance of existing algorithms commonly employed in iris recognition. By refining and optimizing these algorithms, we aim to achieve higher accuracy and reliability in identifying individuals based on their iris patterns. Ultimately, our research work is motivated by the goal of utilizing iris images captured in unconstrained environments and developing algorithms capable of accurately determining the presence or absence of an individual. Through our research, we aspire to contribute to the advancement of biometric identification systems, improving their effectiveness and applicability across various domains..

6. Scope of the research work

The utilization of human biometric identification and recognition processes extends to numerous applications in our daily lives, spanning from domestic settings to workplaces such as banks, internet services, industries, offices, automobiles, educational institutions, retail stores, defense sectors, space exploration, transportation systems, mobile devices, computers, passports, and more. Biometrics can be employed in both verification and identification modes. In identification mode, a biometric sample is obtained to facilitate further recognition purposes. The iris recognition system (IRS) is then used to detect the presence of an individual in the saved database during the testing phase. In this research work, the IRS is deployed to serve the dual role of identifying persons and conducting recognition tasks.

The primary objective of this research is to develop efficient algorithms for iris recognition in unconstrained environments. The proposed algorithms will be compared with existing methods using two widely used tools: Matlab and LabVIEW. While many researchers have focused on constrained environments, only a few have addressed the challenges posed by unconstrained scenarios. Therefore, this research aims to fill this gap by developing hybrid algorithms that can overcome security and recognition issues prevalent in various fields. Furthermore, the scope of this research work is to enhance the sensitivity of commonly used existing algorithms developed by different authors. By leveraging the advantages of hybrid algorithms and building upon existing techniques, we aim to improve the performance and accuracy of iris recognition systems. By conducting this research, we strive to make significant contributions to the field of biometrics, addressing the limitations faced in real-world applications and advancing the sensitivity and reliability of iris recognition technologies..

7. Outcome of the research work

The research work aims to achieve several outcomes. First and foremost, the development of novel algorithms in the

Matlab/LabVIEW environment for automatic iris recognition in unconstrained environments. These algorithms will be designed to minimize computational time while maintaining high accuracy. By addressing the drawbacks identified in previous research conducted by fellow researchers, the developed algorithms will enhance and improve the performance of existing iris recognition methods. The focus will be on overcoming the challenges posed by unconstrained environments, such as variations in image quality, acquisition angle, occlusion, pupil dilation, image blur, and low contrast.

Another key outcome of the research work is the creation of an automated graphical user interface (GUI) specifically designed for iris recognition purposes. This GUI will provide a user-friendly interface for capturing and processing iris images, facilitating the recognition process. By showcasing the effectiveness of the developed algorithms and the efficiency of the automated GUI, the research work will contribute to the advancement of iris recognition technology. The aim is to demonstrate that the proposed algorithms outperform existing methods in terms of computational time and accuracy, ultimately providing a more robust and reliable solution for iris recognition in unconstrained environments..

8. Proposed Methodology

The proposed system for automatic iris recognition, which will be developed in our future research work, consists of two main phases: the iris enrolment or training phase and the iris recognition or evaluation/testing phase. To conduct our research, we will utilize databases such as BATH, IIT Delhi, UPOL, CASIA IrisV4, and UBIRIS, which provide a variety of iris images for analysis. The overall system can be summarized as a series of interconnected blocks, each serving a specific function. These blocks will be incorporated into our research work. The key blocks include the Database block, responsible for storing the iris images; the Image Acquisition/Capturing block, which involves capturing the iris images for processing; the Gray Scale Conversion block, which converts the acquired images to grayscale; the Identification of ROI (Region of Interest) block, which identifies the region containing the iris; and the Pre-processing block, which prepares the image for further analysis.

Other important blocks in the system include Re-sizing, which adjusts the size of the iris image; Boundary Detection, which identifies the boundaries of the iris; Segmentation, which separates the iris from the surrounding areas; Localization, which precisely locates the iris within the image; and Normalization, which ensures consistent representation of the iris features. The system also includes blocks for Noise Removal, Enhancement, Feature Processing, Feature Extraction, and Feature Encoding, all of which contribute to extracting relevant features from the iris image. The extracted features are then subjected to Matching using suitable algorithms and classifiers for comparison with the stored templates in the Database. The Testing block performs the evaluation and decision-making process, determining whether the iris is recognized or not. The system can be used for both authentication and identification purposes.

The overall working concept of the automatic iris recognition system is depicted in a flow chart (Fig. 1), which illustrates the sequential flow of the various blocks. This system aims to provide efficient and accurate iris recognition by incorporating advanced algorithms and techniques into each processing stage..

- The input to the system is an image of a person's eye seeking authorization. The first step involves pre-processing the inputted image.
- In the pre-processing phase, the original image is enhanced, and then the iris within the image is localized. After iris localization, the pupil is localized by

removing any occlusions present in the eye image. Various pre-processing techniques such as CED, CHT, HT, FTM, SOM, OTSU, BDM, and MO methods will be employed to process the image before feature extraction.

- Subsequently, a hybrid combination of LBP, GW, GCW, HSVD, SFTA, GLCM, FF, and CSA methods will be utilized to extract various features from the iris image.
- Once the aforementioned steps are completed, the feature vectors of the iris image will be prepared for comparison with the stored feature vectors in the database, serving as reference templates.
- The final step involves classifying the test iris image using hybrid combinations of classifiers, including m-SVM, HD, HM, SM, KDB, ANN, and RBFNN methods, as indicated in the title of our research work.
- Consequently, if the stored feature vectors and the extracted template of the test iris image match, the person will be verified and recognized. Otherwise, they will not be recognized.

The general proposed data flow-diagram that is going to be employed in this research work is shown in Fig. 1. The functioning of the proposed Iris Recognition System (IRS) method that is going to be developed by us is presented in the Fig. 2. The recognition is going to be done in 2 phases, viz., enrolment phase & the verification phase. The step by step execution of the program that is going to be developed by us w.r.t. the 2 phases is presented as follows.

Block 1 (image acquisition) : Input to the proposed algo is an image of a person's eye taken from the CASIA V4 database under unconstrained environments (bad illumination), i.e., image resolution is very low.

Block 2 (Edge detection) : Identify ROI (iris) and processing is carried out as the next step to detect the edges of the pupil and the iris of the human eye. Note that OTSU method is going to be used here.

Block 3 (Segmentation) : In this step, the internal & external circles of iris is going to be determined. Next, using the output of the next step, the ROI is going to be being determined. Note that OTSU method is going to be used here.

Block 4 (Feature extraction) : Then, the various features of enhanced iris pic are going to be obtained by the hybrid combination of hausdroff fractal dimension method & the SFTA method.

Block 5 (Knowledge base creation) : Here, the knowledge base creation of the extracted features of the iris is going to be carried out in this step with all the available features of the segmented & extracted iris part. Similarly, all the other iris images are going to be processed & stored in the block 5 as standard templates. Here, all the images after analyzing & processing are going to be stored as the feature iris templates, which can be used for comparision purposes.

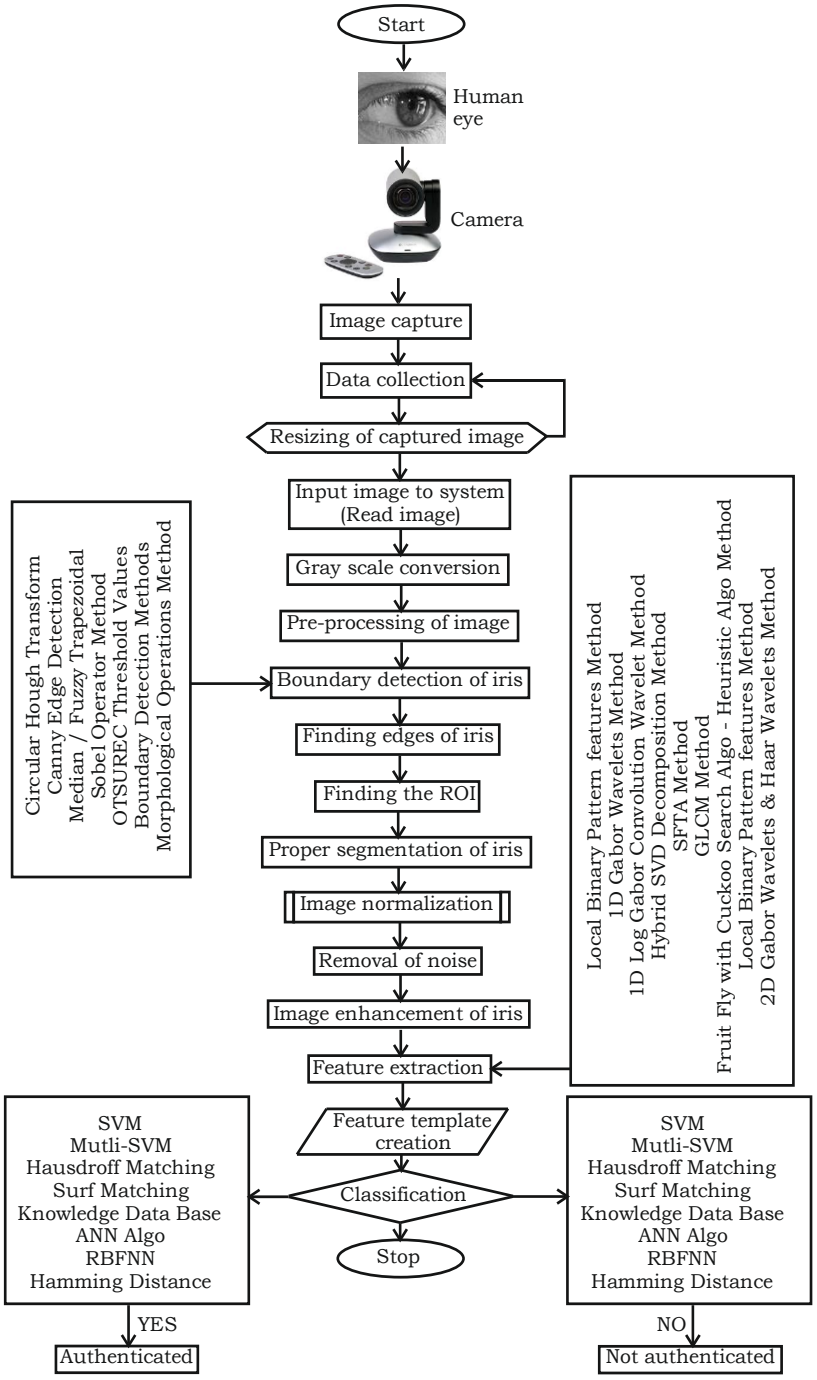

Fig. 4 : General flow-chart for the detection of iris in unconstrained environments

Verification phase : In the verification phase, the iris of the test person that is going to be authenticated or recognized/matched is also taken from the standard database (block-1), resized, edges are identified, proper segmentation of the iris is done, features are extracted, classified using ANN & correlated with feature patterns which are already saved in trained DB (block-6). Now, to determine whether an iris of a particular person is present in a class of parts or not, the verification scheme is employed as shown in the lower part of the block diagram as shown in the Fig. 2. After comparing the test iris with the iris data stored in the database, if a match is found, the person will be verified, authenticated, matched, or recognized. However, if no match is found, the person will be rejected.

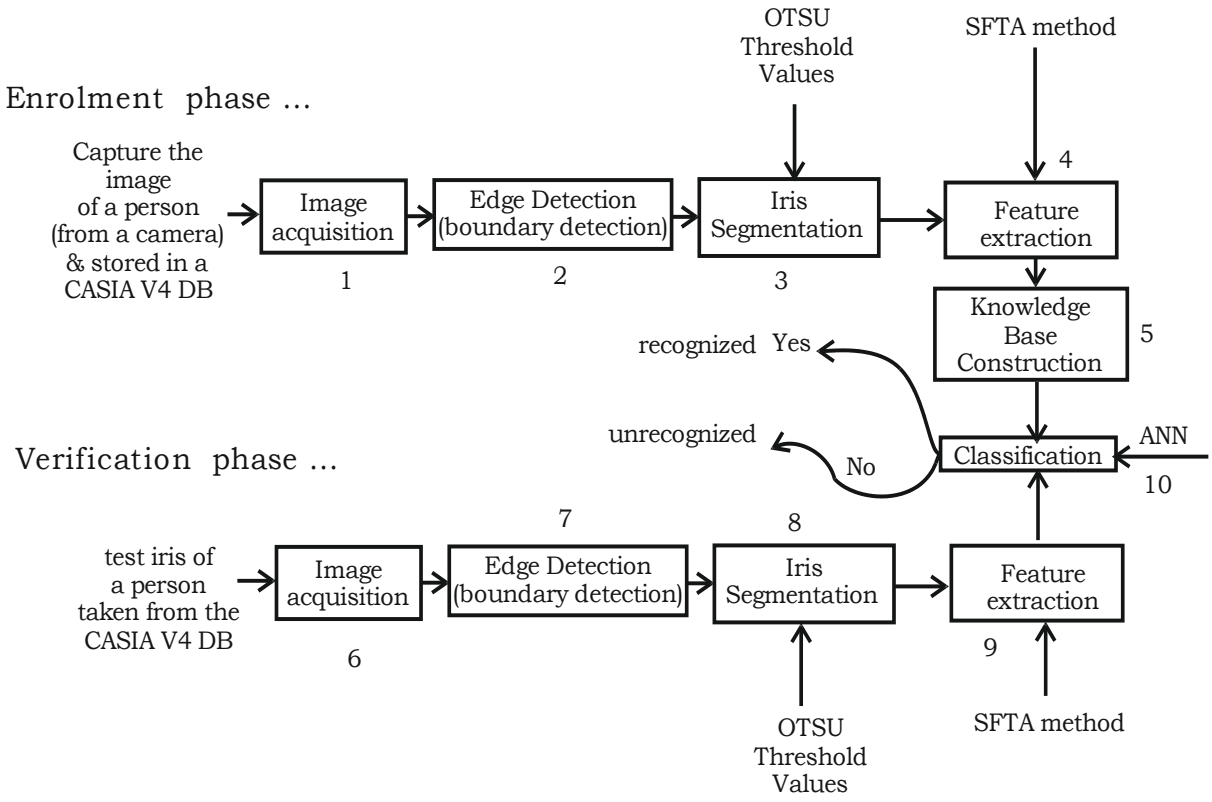

Fig. 5 : Proposed block-diagram of the iris authentication scheme for unconstrained environments

1. Block 6 (image acquisition) : Input to the proposed algo is also one of the image of a person's eye taken from the standard database under unconstrained environments (bad illumination light), say the test iris image (query).
2. Block 7 (Edge detection) : Identify ROI (iris) and processing is going to be carried out as the next step to detect the edges of the pupil and the iris of the human eye.
3. Block 8 (Segmentation) : In this step, the internal & external circles of iris is going to be determined. Next, using the output of the next step, the ROI is going to be being determined.
4. Block 9 (Feature extraction) : Then, the various features of the enhanced test iris image is going to be extracted.
5. Block 10 (Classification) : Once parameters of iris from previous block 5 are found out one by one which are present in the standard database, then they are going to be classified using the neural network algorithm (ANN) into recognized & unrecognized ones.

End result : After comparing the test iris with the iris data stored in the database, if a match occurs, the person is verified, authenticated, matched, or recognized. However, if no match is found, the person is rejected.

9. Conclusions & Advantages

The research will focus on developing an efficient and secure approach for biometric authentication using iris recognition. A comprehensive literature review will be conducted, gathering research papers and works from various sources such as college libraries, KIT library, VTU library, IITs, IISc, as well as input from friends, colleagues, and fellow researchers. The aim is to examine and analyze the limitations and drawbacks of existing research in this field. The research problem has been defined as "New developments in the iris authentication of humans for complex unconstrained environments using hybrid

methods". The coding and implementation of the proposed approach will be carried out in the Matlab and LabVIEW environments. Simulation results will be observed, and conclusions will be drawn based on the findings.

The purpose of the research work is to address the limitations of existing research on biometric authentication using iris recognition and develop a fast and efficient authentication system. The research objectives will be fully achieved by identifying and overcoming the selected drawbacks through comparison with other approaches. The proposed methodology offers several advantages, including simplicity and ease of implementation, reduced complexity, shorter execution time, faster authentication and recognition, ease of feature extraction due to the fine texture of the iris, improved speed of the recognition system, significant reduction in false acceptance ratio, robust performance across different image qualities, high reliability for authentication, and stability over a lifetime. The developed recognition system will have a small number of parameters and employ hybrid methodologies, making it highly suitable for security applications in various settings, including personal checks in engineering applications.

The proposed iris recognition technique for unconstrained environments has a wide range of applications in various fields. Some of the key applications include:

- Banking's ATM: Enhanced security for ATM transactions, reducing the risk of unauthorized access to bank accounts.
- Educational Institutions: Secure access control for students and staff, ensuring only authorized individuals can enter restricted areas.
- Internet Banking: Strengthened authentication for online banking, safeguarding sensitive financial information.
- Mobiles: Biometric authentication for unlocking mobile devices, protecting personal data from unauthorized access.
- Social Welfare: Detection of multiple frauds in person authentication, preventing misuse of social welfare benefits.
- Airports: Improved security scanning to verify the identity of travelers, ensuring safer air travel.
- Computer Logins: Biometric-based login systems as an alternative to traditional passwords, enhancing cybersecurity.
- Credit Card Authentication: Increased security for credit card transactions, reducing the risk of fraud.
- E-commerce: Secure financial transactions on e-commerce platforms, providing a safe online shopping experience.
- Person Tracking: Effective tracking of individuals in various surveillance scenarios for security purposes.
- Border Control: Reliable identification of individuals during immigration checks, enhancing border security.
- Hospitals: Access control for medical staff and patients, ensuring the privacy and safety of medical records.
- Welfare Distribution: Efficient distribution of welfare benefits to the intended recipients, reducing fraud.
- Biometric Passport: Enhanced security for passport verification, preventing identity theft.
- Forensics: Utilized in criminal investigations for identifying suspects based on iris scans.
- Aadhar: Integration with Aadhar for secure authentication of individuals for various government services and benefits.
- Overall, the proposed iris recognition system holds significant potential to

enhance security, efficiency, and reliability across diverse applications in the modern world..

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