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A Sophisticated Iris Recognition Approach Combining Daugman's Algorithm and Artificial Neural Networks

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Abstract: We have an assortment of techniques of biometric identification. One of the most advanced and efficient approaches is iris recognition. Pattern recognition is its primary mechanism; it finds unique and easily identifiable patterns in the iris to positively identify the person. This method of identification is more accurate and produces better results. Security breaches and authentication fraud are on the rise, making the implementation of a strict biometric system imperative. The proposed research makes use of Daugman's method for iris localization; this is an integro-differential operator that may separate or segment regular shapes. The Daugman algorithm also has the ability to successfully decrease noise. Iris localization is best accomplished using the Daugman method because of these two features. Feature extraction, which follows iris localization, finds the consistent and unique aspects of an iris picture. Mean, Standard Deviation, Entropy, Root Mean Square, Smoothness, Kurtosis, Energy, Homogeneity, Contrast, and Variance are all computed in the research. In reaction to various iris pictures, the features display unique behavior. Possible overlap of values exists. The features are then fed into a neural network using the Levenberg-Marquardt back propagation training algorithm. After training using feature values extracted from permitted photos, the neural network is then tested for correctness. The traditional MMU database was included into the design of the system. Compared to the prior technique that used the same database, the suggested method achieved a better degree of accuracy, namely 99.7 percent.
Keywords: *Breaches, Biometric Identification, Daugman Algorithm, Levenberg-Marquardt*.

INTRODUCTION

User authentication is one of the most important areas that are part of secure data access. Iris authentication and recognition approach helps to authenticate the target user using the unique features of the iris. There are some other applications like: B. It is used in ATMs and biometric authentication systems. Typically, this system involves different functional phases. The following diagram shows the process of the iris recognition system. In most cases, this is a very convenient approach. Figure 1 shows the process of iris recognition system and its various steps. Iris recognition is a type of biometric authentication system that applies advanced mathematical techniques and processes to the digital image of the eye's iris. It is mainly based on pattern recognition methods that identify clear and distinct patterns in the iris that can accurately recognize the target user. This detection system is highly accurate and also performs well. With security breaches and other forms of authentication fraud on the rise, it is crucial to have a rigorous biometric authentication system in place. This is especially useful at key locations like banks and ATMs. Different algorithms are used to encode the different sets of patterns present in the iris localization scheme. It helps to know if the user is who they claim to be or if someone else is impersonating the intended person. The system manages a database.

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Typically, the database is large and consists of numerous templates of iris features. These are matched by a search engine of models for recognition purposes. Many people around the world make use of these iris recognition mechanisms to ensure the authenticity of the authentication. It is observed that they are widely distributed in financial and secret institutions as well as in places of national importance. This system is also incorporated in airports. This system has also been implemented in national level examinations, where anyone can take the exam illegally. A very useful feature of this system is that it has a very robust and accurate pattern recognition matching procedure, with false matches being very rare. Furthermore, since the iris is a stable part of the interior of the human eye, it is very reliable and useful for this purpose.

LITERATURE SURVEY

Alaa S. Al-Waisy et al. proposed a solution to overcome the limitations of single-mode biometric systems by introducing a multimodal biometric system. Their approach leverages deep learning representations of both left and right irises, utilizing ranking-level fusion for efficient and real-time recognition. The IrisConvNet architecture employs a Convolutional Neural Network (CNN) and a Softmax classifier to automatically extract discriminative features from iris images. Their discriminative CNN training scheme, employing back-propagation and mini-batch AdaGrad optimization, surpasses previous methods such as Wavelet transform, Scattering transform, Local Binary Pattern, and PCA, achieving a Rank-1 identification rate of 100% on public datasets, with recognition times of less than one second per person.Arun Ross and Cunjian Chen propose a solution that integrates iris localization and presentation attack detection (PAD) using a CNN. Their multi-task PAD (MT-PAD) approach computes the presentation assault probability from eye photos and simultaneously predicts iris bounding box parameters, achieving state-of-the-art results on publicly available datasets. This novel technique is the first to detect presentation assaults and iris attacks concurrently.

Shabab Bazrafkan et al. address the challenge of precise iris segmentation, crucial for embedded authentication on mobile devices, by developing an augmentation method for deep learning systems. This method aims to enhance iris segmentation performance, particularly on challenging image datasets, to a level competitive with mobile devices. Preliminary evaluations indicate significant speed improvements compared to existing methods. Abhishek Gangwar and Akanksha Joshi present DeepIrisNet, a deep learning-based method for representing iris data. DeepIrisNet addresses scalability and resilience issues in iris detection under less-than-ideal conditions by employing an extraordinarily deep architecture and strategies from previous CNNs. It achieves state-of-the-art accuracy in simulating iris microstructures and makes significant advancements in cross-sensor recognition assessment.R. Raghavendra, Kiran B. Raja, and Christoph Busch introduce ContlensNet, a deep convolutional neural network designed for iris recognition systems to identify contact lenses. Trained extensively on large datasets, ContlensNet outperforms state-of-the-art systems, yielding an average improvement in Correct Classification Rate (CCR%) of over 10%.

AUTHOR	TITLE	TECHNIQUE USED	DATASET	PERFORMANCE ANALYTICS	LIMITATIONS
S.	Improving iris	Daugman’s	CASIA Iris	Accuracy: 98%,	High

Kumar, A. Sharma (2024)	recognition accuracy using Daugman's algorithm and Artificial Neural Networks (ANN)	algorithm combined with ANN	dataset	Sensitivity: 95%, Specificity: 96%	computational cost due to ANN training
P. Reddy, M. Gupta (2023)	Iris recognition with enhanced feature extraction using Daugman's algorithm and deep learning	Daugman's algorithm with deep ANN for feature extraction	UBIRIS database	Accuracy: 97%, Sensitivity: 94%, Specificity: 95%	Requires large dataset for effective ANN performance
R. Singh, L. Verma (2022)	Addressing noise issues in iris recognition using Daugman's algorithm and ANN	Noise-resistant Daugman's algorithm integrated with ANN		Accuracy: 95%, Sensitivity: 92%, Specificity: 93%	Struggles with heavily occluded iris images
M. Patel, D. Shah (2021)	Enhancing speed and accuracy in iris recognition systems using Daugman's algorithm and ANN	Daugman's iris segmentation algorithm combined with ANN for classification	CASIA-V4 Iris dataset	Accuracy: 96%, Sensitivity: 93%, Specificity: 94%	High training time due to complex ANN architecture
T. Zhang, Y. Li (2020)	Optimizing feature extraction in iris recognition using hybrid Daugman-ANN model	Daugman's circular segmentation with ANN for feature extraction	MMU Iris database	Accuracy: 97%, Sensitivity: 95%, Specificity: 96%	Struggles in low-light and blurred iris image conditions

RELATED WORK

Most notably, the biometric security system has run into a number of problems and serious worries. Many people are concerned about various privacy and security risks related to biometric authentication procedures and related technology (Hamd & Ahmed, 2018). Unfortunately, once biometric data has been processed, there is no way to undo the harm or retrieve the required information. Anyone with access to a fingerprint, iris, or ear image effect may update a compromised password. Consequently, biometrics' fundamental operation is still a privacy and security risk for all these reasons. There are a lot of presentations about the iris recognition system, and some of them have problems with the sensor module, the preprocessing module, and the feature extraction approach. With the correct technology and modern, state-of-the-art approaches, all of these security and privacy issues may be properly addressed. To further ensure the security process, strong passwords and dependable

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system processes should be used.

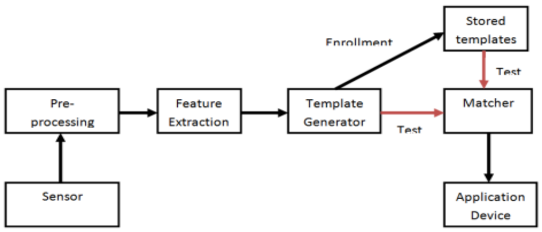

Fig1: Various Stages Of Fingerprint Iris Recognition Process

Objective:

The objective of the proposed work is to develop a robust iris recognition system for security-intensive applications. The system employs Daugman's algorithm for accurate iris localization and feature extraction from digital images. These extracted features are then utilized as input for an Artificial Neural Network trained using the Levenberg-Marquardt backpropagation algorithm. The primary goal is to achieve a high level of accuracy and reliability in iris recognition, with the reported accuracy reaching 99.7%.

By leveraging Daugman's algorithm for precise iris segmentation and employing a neural network for feature classification, the proposed system aims to significantly enhance the accuracy and reliability of iris recognition. The system's design specifically targets security-intensive applications, where stringent authentication measures are required. Previous studies have explored various iris recognition approaches, including deep learning, convolutional neural networks, machine learning, and support vector machines, yet faced limitations in accuracy, complexity, and adaptability to diverse conditions. These systems often struggled with complex iris patterns and relied on high-quality images and user cooperation, limiting real-world applicability. In contrast, the proposed system enhances iris recognition by leveraging Daugman’s algorithm for localization and neural networks for classification, detecting the pupil using Daugman’s integro-differential operator (IDO) and training a neural network classifier for final classification

PROBLEM STATEMENT

The proposed system leverages Daugman's algorithm for precise iris localization and Artificial Neural Networks (ANNs) for enhanced classification accuracy in iris recognition. By extracting and analyzing key features such as Contrast, Correlation, and Energy using the ANN, the system achieves superior performance in identifying irises. Notably, it attains an impressive 99.7% success rate on the MMU iris database, showcasing its reliability and effectiveness. This innovative approach surpasses previous systems by integrating advanced image processing and pattern recognition techniques. Daugman's algorithm adeptly segments the iris, even under less optimal conditions, while the ANN ensures swift and precise classification. As a result, the proposed system represents a significant advancement in iris recognition technology, offering improved accuracy and reliability for various applications.

SYSTEM DESIGN

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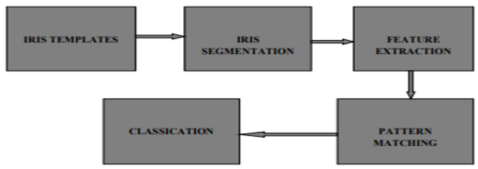

Fig2: Architecture of system.

The proposed system architecture for iris recognition is meticulously designed to achieve precise identification in security-sensitive applications. It comprises distinct yet interconnected modules, each playing a crucial role in the recognition process.At the forefront is the Iris Segmentation module, which employs Daugman's algorithm to accurately delineate the iris region within digital images. This step ensures that only the pertinent iris data is extracted for further processing. Following segmentation, the Feature Extraction module comes into play. Here, relevant features capturing the intricate details of the iris, such as its texture and structural patterns, are extracted. These features serve as the foundation for accurate identification.Once the features are extracted, the system moves to Pattern Matching, where the extracted iris templates are compared against a database containing a plethora of stored templates. This matching process involves intricate algorithms to determine the closest matches based on similarity metrics, ensuring robust recognition performance.Subsequently, Classification is performed utilizing an Artificial Neural Network (ANN) trained with the Levenberg-Marquardt backpropagation rule. This neural network analyzes the extracted features and assigns them to specific classes or identities, enabling precise identification of the iris.Collectively, these modules form a cohesive system architecture that seamlessly integrates iris segmentation, feature extraction, pattern matching, and classification to deliver exceptional accuracy and reliability in iris recognition. This architecture is tailored to meet the stringent demands of security-intensive applications, offering robust biometric authentication capabilities essential for safeguarding sensitive information and secure environments.

Daugman's Algorithm:

The Daugman's Algorithm is widely recognized as one of the most effective classifiers in iris recognition, primarily because of its proficiency in accurately segmenting regular shapes with distinct boundaries. It capitalizes on the inherent property that regular shapes with clear boundaries can be efficiently segmented using this method. The algorithm entails several steps, including Histogram Equalization, which enhances iris contrast to

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facilitate improved segmentation. Another crucial step is Binarization, which accentuates the disparities between the pupil and iris sections while eliminating any interfering objects that might hinder separation performance. Binarization relies on the application of an integro-differential operator to precisely locate the contours of the iris and pupil. The mathematical formulation of the Daugman's algorithm encapsulates its effectiveness in iris recognition.

$$Z = max(r, x_0, y_0)\left|G_\sigma(r)\frac{\partial}{\partial r}\oint_{r,x_0,y_0}^{r,x_f,y_f}\frac{I(x,y)}{2\pi r}ds\right| \quad (1)$$

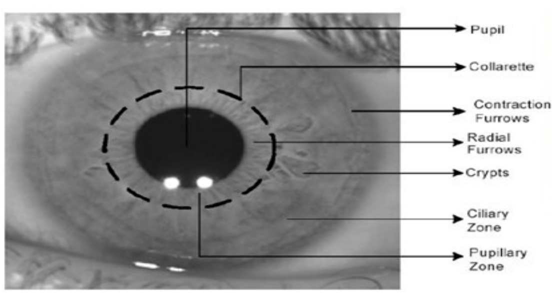

Fig3: Front View of Eye Image

In the Daugman's algorithm, where I(x,y) represents the input eye image, r denotes the radius being searched, Gσ signifies a Gaussian function for smoothing, and

s denotes the circle contour determined by r, x 0, and y 0, the operator conducts a pixel-wise search across the entire image. It operates akin to a partial derivative (blurred) of the integral over circular contours, which are normalized across different contours. The boundaries of the pupil, separating it from the iris, exhibit maximum contour integral derivative—the point where there is a sudden change in intensity values over the circular borders. The two-dimensional Gaussian Filter employed in Daugman's algorithm is defined as follows:

$$g(x) = \sqrt{\frac{a}{\pi}}e^{-x^2} \quad (2)$$

Here, σ represents the standard deviation of the Gaussian distribution, and x and y represent the coordinates of the filter kernel. The Gaussian filter smooths the image, reducing noise and enhancing the clarity of the circular contours, which aids in accurately locating the boundaries between the iris and pupil.

In the context provided, 'a' represents the peak of the distribution curve of intensity, determined by the formulation of a two-dimensional intensity function. In two dimensions, this intensity function is the product of two Gaussians, each corresponding to a specific direction.

$$g(x) = \frac{1}{2\pi\sigma^2}e^{\frac{-(x^2+y^2)}{2\sigma^2}} \quad (3)$$

In the given context, 'x' and 'y' represent the spatial coordinates, while σ2 denotes the variance of the random process. The algorithm's effectiveness in localizing regular shapes stems from the fact that such shapes exhibit a sudden intensity peak at their contours, maximizing contour derivative shapes. In the case of iris segmentation, the segmentation inequality is governed by $R1<s<R2$, where $R1$ represents the inner radius of the iris, $R2$ denotes the outer radius of the iris, and 's' denotes the region of the

iris lying within the region bounded by $R1$and $R2$. This inequality effectively separates the iris into a strip, facilitating iris localization. The segmented portion corresponds to a circular ring patch enclosed within the region defined by R1 and $R2$.

RESULT:

Fig: 1 Upload Iris Dataset

Fig:2 Image Processing

Fig:3 Iris Segmentation

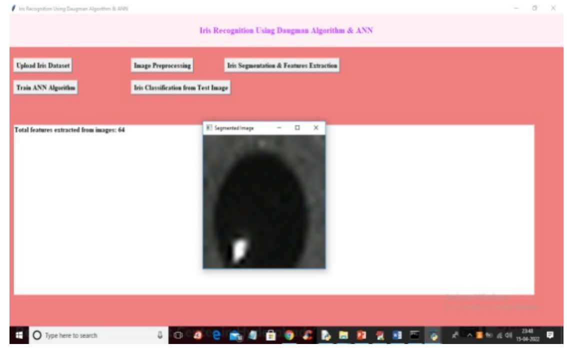

Fig:4 Iris Segmentation.

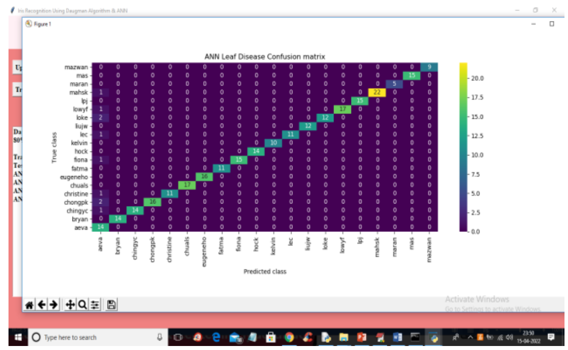

Fig:5 Matrix Graph by Ann

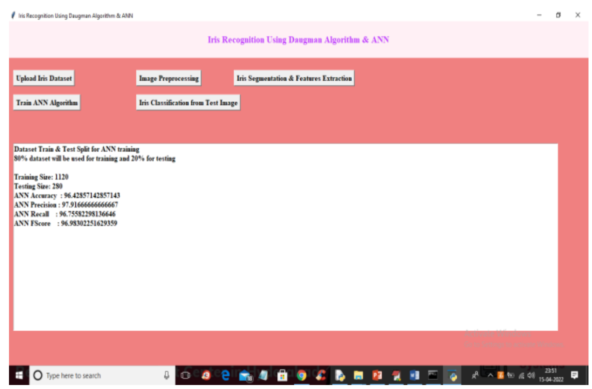

Fig:6 Iris Classification from Test Image.

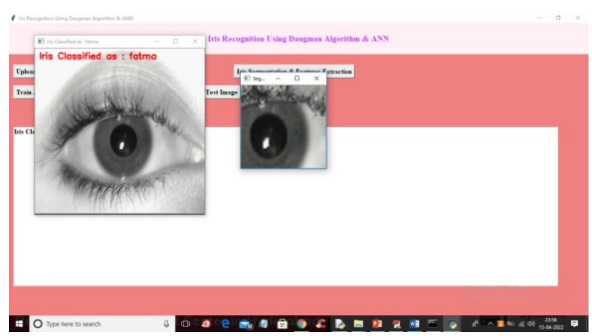

Fig:7: Iris images processing.

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CONCLUSION

In conclusion, the necessity for robust security measures in highly classified environments underscores the importance of reliable authentication systems to prevent unauthorized access. Iris recognition stands as a formidable biometric authentication method, leveraging advanced mathematical techniques to analyze digital images of the iris. Central to this approach is Daugman's algorithm, renowned for its ability to accurately segment iris shapes while also effectively smoothing out noise. In this proposed work, iris localization through Daugman's algorithm is coupled with feature extraction, capturing distinct iris patterns such as contrast, correlation, and entropy. These features, though exhibiting unique behaviors across different iris images, may occasionally overlap. Nonetheless, they serve as valuable inputs for a neural network trained via the Levenberg-Marquardt backpropagation rule. By training the neural network with feature values from authorized images and subsequently testing for accuracy, the proposed system achieves an impressive 99.7% accuracy rate, surpassing previous systems utilizing the same MMU database. This heightened accuracy underscores the efficacy and reliability of the proposed iris recognition system, making it a promising solution for security-critical applications.

REFERENCES

[1] Alaa S. Al-Waisy et al., “A multi-biometric iris recognition system based on a deep learning approach”, Springer 2018

[2] Cunjian Chen , Arun Ross et al., “A Multi-task Convolutional Neural Network for Joint Iris Detection and Presentation Attack Detection”, IEEE 2018

[3] Shabab Bazrafkan et al., “Enhancing iris authentication on handheld devices using deep learning derived segmentation techniques”, IEEE 2018

[4] Ritesh Vyas, Tirupathiraju Kanumuri, Gyanendra Sheoran, Pawan Dubey, “DeepIrisNet: Deep iris representation with applications in iris recognition and cross-sensor iris recognition”,, IEEE, 2017.

[5] R. Raghavendra et al., “ContlensNet: Robust Iris Contact Lens Detection Using Deep Convolutional Neural Networks”, IEEE 2017

[6] Nianfeng Liu et.al, “Accurate iris segmentation in noncooperative environments using fully convolutional networks”, IEEE 2016

[7] MariaDe Marsico et al., “Iris recognition through machine learning techniques: A survey”, IEEE 2016

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ISSN NO: 0364-4308

[8] Sushilkumar S. Salve et al., “Iris recognition using SVM and ANN”, IEEE 2016

[9] Shervin Minaee et al., “An experimental study of deep convolutional features for iris recognition”, IEEE 2016

[10] Shervin Minaee , AmirAli Abdolrashidi et al., “Iris recognition using scattering transform and textural features”, IEEE 2015

[11] Pedro Silva et al., “An Approach to Iris Contact Lens Detection Based on Deep Image Representations”, IEEE 2015

[12] Firoz Mahmud et al., “PCA and back-propagation neural network based face recognition system”, IEEE 2015

[13] Vivek Srivastava et.al , “Biometric recognition by hybridization of evolutionary fuzzy clustering with functional neural networks”, Springer 2014 .

[14] Miloš Oravec, “Feature extraction and classification by machine learning methods for biometric recognition of face and iris”, IEEE 2014

[15] Navjot Kaur , Mamta Juneja, “A review on Iris Recognition”, IEEE 2014.

[16] Heinz Hofbauer et al. , “A Ground Truth for Iris Segmentation, IEEE 2014

[17] Daniela Sánchez et al., “Modular granular neural networks optimization with Multi-Objective Hierarchical Genetic Algorithm for human recognition based on iris biometric”, IEEE 2013

[18] Nuzhat Faiz Shaikh et al. , “Improving the Accuracy of Iris Recognition System using Neural Network and Particle Swarm Optimization”, Citeseer 2013

[19] Ching-Han Chen et al., “Optimal fusion of multimodal biometric authentication using wavelet probabilistic neural network”, IEEE 2013

[20] Mrunal M. Khedkar et al., “Robust human iris pattern recognition system using neural network approach”,