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IRIS IDENTIFICATION WITH ANN AND DAUGMAN'S ALGORITHM

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ABSTRACT

Among the array of biometric identification techniques, iris recognition stands out as one of the most advanced and efficient methods. It relies on pattern recognition to discern unique and easily identifiable patterns within the iris, facilitating precise identification of individuals. This approach offers superior accuracy and results compared to other methods. Given the increasing instances of security breaches and authentication fraud, implementing a robust biometric system is essential.The proposed research utilizes Daugman's method for iris localization, leveraging its integro-differential operator capability to effectively separate regular shapes and reduce noise. Daugman's algorithm is particularly well-suited for iris localization due to these features. Following iris localization, feature extraction identifies consistent and unique aspects of an iris image. Various statistical measures such as mean, standard deviation, entropy, root mean square, smoothness, kurtosis, energy, homogeneity, contrast, and variance are computed in the research. These features exhibit distinct behavior in response to different iris images, though some overlap in values may occur.Subsequently, these features are inputted into a neural network utilizing the Levenberg-Marquardt backpropagation training algorithm. The neural network is trained using feature values extracted from authorized photos and then tested for accuracy. The traditional MMU database is integrated into the system design. Compared to previous techniques utilizing the same database, the proposed method achieves a higher degree of accuracy, specifically reaching 99.7 percent accuracy.

Index Terms:—Breaches,Biometric Identification,Daugman Algorithm,Levenberg-Marquardt.

I.INTRODUCTION

1.1 Research Aim:

- This project aims to blend the robust feature extraction of Daugman’s Algorithm with the adaptability of ANNs.
- We aim to create an iris recognition system that redefines biometric technology by offering unparalleled accuracy and efficiency, thus rendering it exceptionally suitable for real-time applications.
- The first step is to use DAUGMAN's algorithm to segment the iris. The Ann algorithm then receives the segmented iris and saves the information it has extracted.

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1.2 The Advent of Iris Recognition:

- In the field of biometric security, iris recognition emerges as a standout due to its precision and uniqueness. Each iris has a complex pattern,distinct even among identical twins, making it a highly reliable identifier .
- Challenges and the Need for Advancements: However,factors like environmental conditions and processing speed present challenges to current iris recognition systems. Addressing these issues is crucial for enhancing both the accuracy and efficiency of these systems.

1.3 Daugman's Algorithm and the Role of ANN:

- Daugman's Algorithm has been foundational in iris recognition, particularly in pattern detection and extraction. To further advance this technology, integrating Artificial Neural Networks (ANN) presents a promising approach.
- ANNs are adept at pattern recognition and learning, which can significantly improve the performance of iris recognition systems, especially in varied and challenging conditions.

1.4 Problem Statement:

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 system processes should be used.

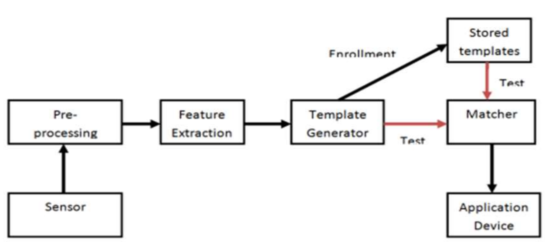

Fig1: Various Stages Of Fingerprint Iris Recognition Process

1.5 Objective:

The proposed work aims to develop a robust iris recognition system tailored for security-intensive applications. It utilizes Daugman's algorithm for precise iris localization and extracts features from

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digital images. These extracted features serve as input for an Artificial Neural Network trained using the Levenberg-Marquardt backpropagation algorithm. The primary objective is to achieve a high level of accuracy and reliability in iris recognition, with reported accuracy reaching 99.7%.

Through the integration of Daugman's algorithm for accurate iris segmentation and the utilization of a neural network for feature classification, the proposed system endeavors to significantly enhance the accuracy and reliability of iris recognition. Its design is specifically tailored for security-intensive applications, where stringent authentication measures are paramount.

II.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%.

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III. EXISTING SYSTEM

While previous studies have delved into multiple iris recognition methodologies, such as convolutional neural networks, and support vector machines, they encountered challenges regarding accuracy, complexity, and adaptability to various conditions. These methods often faced difficulties in dealing with intricate iris patterns and were dependent on high-quality images and user cooperation, which constrained their practical applicability. In contrast, the proposed system improves iris recognition by employing Daugman's algorithm for localization and neural networks for classification. It identifies the pupil using Daugman's integro-differential operator (IDO) and then trains a neural network classifier for the final classification step.

DISADVANTAGES OF EXISTING SYSTEM:

- Iris recognition systems include their struggle with complex iris patterns, dependence on high-quality images and user cooperation, as well as limitations in accuracy, complexity, and adaptability to diverse conditions.
- Iris recognition systems have often exhibited limitations in terms of scalability, requiring substantial computational resources and time for processing large datasets.

IV PROPOSED SYSTEM:

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.

ADVANTAGES OF PROPOSED SYSTEM:

- The proposed system ensures more accurate and reliable iris recognition with reduced classification errors and optimized time complexity.
- The system's advanced techniques result in enhanced security through robust iris recognition, providing an added layer of protection against unauthorized access.

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V. SYSTEM DESIGN

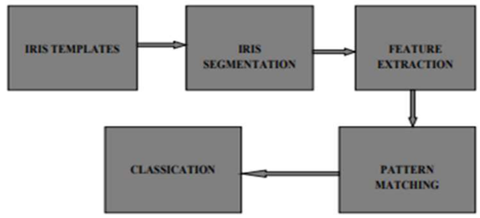

Fig2: Architecture of system.

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.

5.1Daugman’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 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.

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

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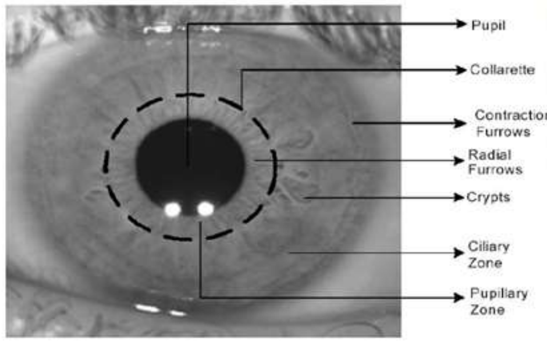

Fig3: Front View of Eye Image

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:

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

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.

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

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

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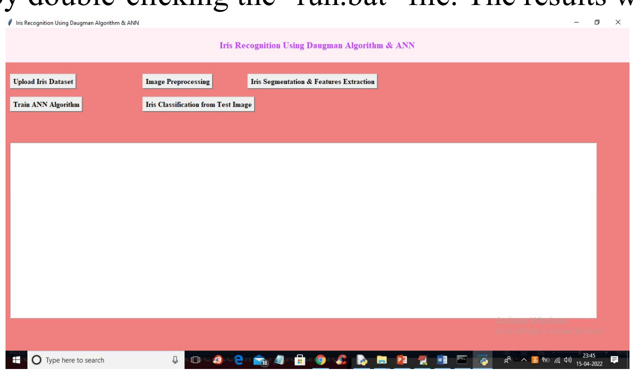
separates the iris into a strip, facilitating iris localization. The segmented portion corresponds to a circular ring patch enclosed within the region defined by R1 and $R2$.

VI.MODULE DESCRIPTION:

The proposed system consists of five interconnected modules designed to facilitate iris recognition:
1.Upload Iris Dataset: This module enables users to upload iris dataset images into the application. Users can provide a set of images containing iris data, which serves as the basis for training and testing the iris recognition system.
2.Image Preprocessing: Upon uploading the dataset, this module preprocesses the images to ensure uniformity and enhance their suitability for subsequent processing steps. Preprocessing involves resizing images to a standard size to facilitate consistent analysis across all samples. Additionally, pixel values are normalized to optimize data representation and improve the efficiency of subsequent algorithms.
3.Iris Segmentation & Feature Extraction: In this critical module, the Daugman algorithm is applied to segment the iris region from the preprocessed images accurately. Once segmented, features or pixel values are extracted from the iris region. These features capture unique characteristics of the iris, such as its texture and patterns, essential for identification.
4.Train ANN Algorithm: This module involves training an Artificial Neural Network (ANN) algorithm using the extracted iris features. The ANN is trained to learn patterns and associations within the feature space, enabling it to classify or recognize iris patterns effectively. The training process utilizes the extracted features as input data and adjusts the network's parameters using the backpropagation algorithm to minimize classification errors.
5.Iris Classification from Test Image: In the final module, users can upload an eye image containing an iris for recognition. The Daugman algorithm is applied to extract the iris region from the test image, which is then passed to the trained ANN model. The ANN predicts the identity associated with the iris based on the learned patterns, enabling accurate classification or recognition of the individual.

VII. RESULT:

Launch the project by double-clicking the "run.bat" file. The results will be shown below.



Use the "Upload Iris Dataset" link up there to submit a dataset that looks like this one.

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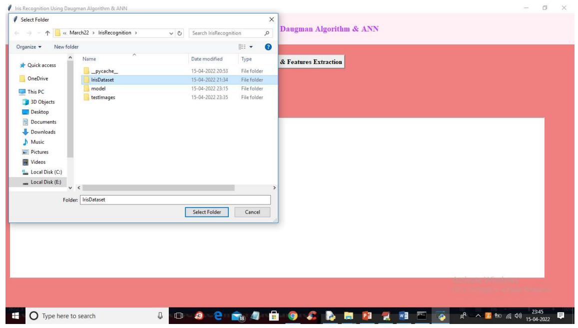
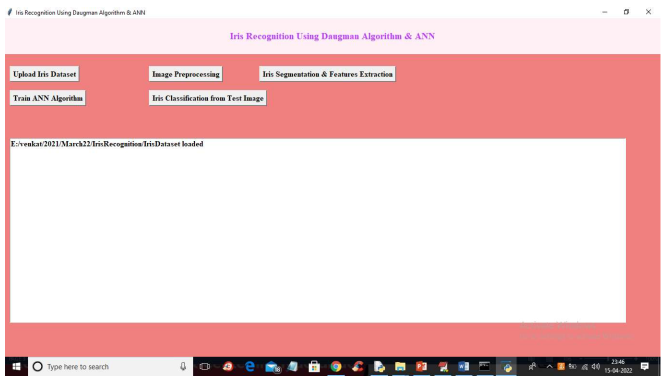
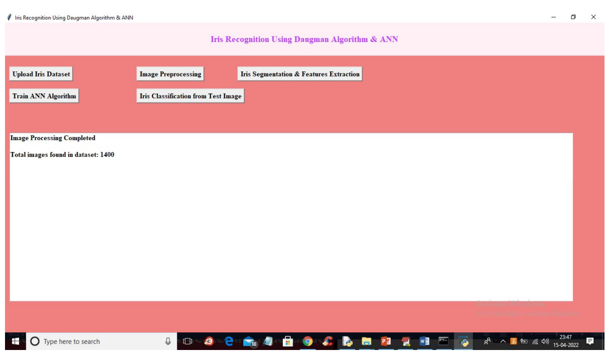


Select and upload the "IrisDataset" folder from the previous page to load the dataset and get the result below. Press the "Select Folder" button thereafter.



The dataset is shown on the screen up top. You may get the result seen below by clicking the "Image Preprocessing" button, which will normalize the pixel values.



As can be seen from the screen capture above, the application has processed 1400 images from the dataset. Select "Iris Segmentation & Features Extraction" to begin iris extraction followed by feature extraction.

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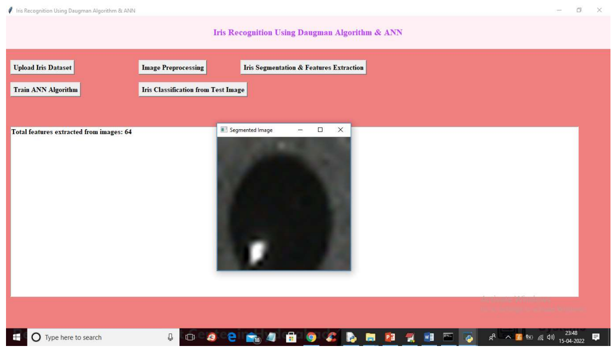
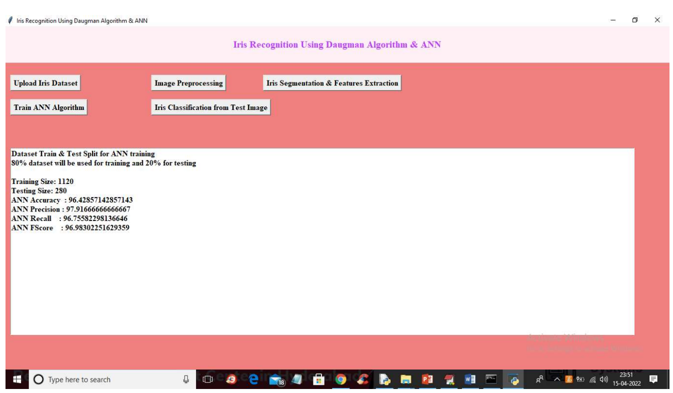


On top of this screen, you can see the iris split and extracted characteristics from every single picture. Every picture has dimensions of 64 by 64 pixels. In order to verify the accuracy of the picture segmentation, I have shown one segmented iris image on the screen above. After you've closed the previous picture, you may train the ANN using the characteristics you extracted by clicking the "Train ANN Algorithm" button. Then, you can see the results below.

The above-mentioned prediction confusion matrix graph was generated by the ANN model. The x-axis shows predicted classes and the y-axis shows TRUE classes. We may now close the above image to get the result below; the graphic displays the maximum number of correct guesses.



To get results for iris recognition or classification, just submit a test image by clicking the "Iris Classification from Test Image" button. Using ANN, we achieved an accuracy of 96% on the following screen.

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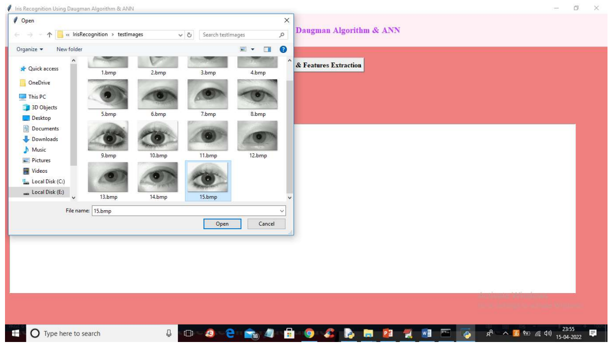
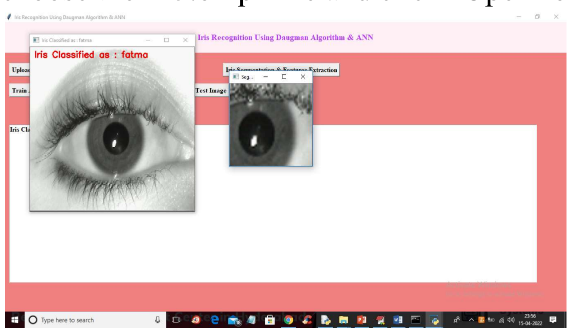
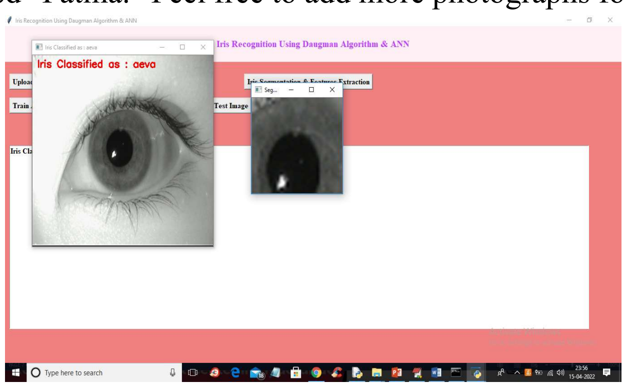


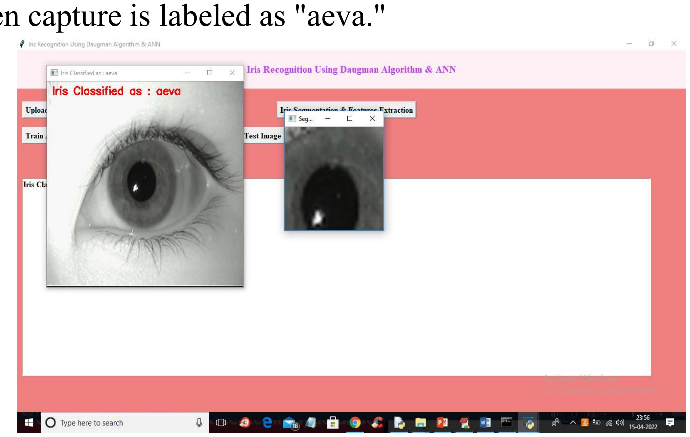
This is what you'll get if you choose the "15.bmp" file and click "Open" on the previous screen.



On the screen that follows, you may see an image that Daugman has segmented, along with an iris that has been named "Fatma." Feel free to add more photographs for testing purposes.



The eye on the top screen capture is labeled as "aeva."



VIII. CONCLUSION

In conclusion, the necessity for robust security measures in highly classified environments underscores

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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.

IX. FUTURE ENHANCEMENT

Looking ahead, there are several promising avenues for advancing iris recognition technology. One potential direction involves refining the algorithms used for iris segmentation and feature extraction to improve accuracy, especially in challenging conditions. Additionally, efforts to enable real-time recognition and integration with emerging technologies like edge computing could enhance the system's practicality and efficiency. Moreover, exploring applications beyond traditional security domains, ensuring accessibility and inclusivity, and addressing privacy and ethical considerations will be vital for the continued development and adoption of iris recognition technology in diverse contexts.

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