International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

IRIS Segmentation using Deep Learning for Recognition

Devarasetti Bindu Madhavi

Student, Rajam, Vizianagaram, 532127, India.

ABSTRACT

Phenotypes include fingerprints, facial patterns, DNA, and iris patterns that are unique to every single individual. Iris has 256 unique features, whereas fingerprints have 40. In iris recognition, people are identified automatically based on their iris patterns. Biometrics have become more reliable and significant as a result of the ability to recognize people based on their irises. With Iris, we are able to provide higher security and privacy based on the needs and actions of the people. Because of its unique texture, lifelong stability, and regular shape, the iris has become a favoured attribute in biometrics. Deep learning based IrisParseNet is an efficient method based on deep learning. In the proposed approach, iris mask and parameterized inner and outer iris boundaries are jointly achieved by actively modelling them into a unified multitask network. In contrast to many previous CNN-based iris segmentation methods, which used popular semantic segmentation frameworks, this method predicts accurate iris masks.

Keywords:: Iris recognition, IrisParseNet, feature, unique, biometric, privacy, security, segmentation.

1. Introduction

In the current digital world, safety is crucial to all of our everyday applications. The iris, face, fingerprint, voice, ear, gait, hand geometry, and signature recognition systems are a few examples of biometric systems used in human identification systems. Iris recognition is regarded as the most dependable and accurate biometric approach now in use because iris patterns have the advantages of randomness, uniqueness, complexity, and stability throughout the course of an individual's lifetime. Iris pattern recognition is utilised for iris-based individual identification since it is statistically unique. To reach the goal of enrolling once but identifying everywhere for iris recognition, it is currently becoming an unstoppable trend. The iris prediction, which might be used in the biometric system, is what causes it.

The human iris possesses incredibly rich patterns, which can be used to create a biometric system that can be used in complex domains including managing restricted areas, controlling databases, authenticating cards, banking services, and more. The four primary modules of an iris recognition system are iris segmentation, iris normalisation, feature extraction, and matching. The most important stage is segmentation since it has an impact on all other stages.

The human iris includes a wide variety of intricate patterns. The four primary modules of an iris recognition system are iris segmentation, iris normalisation, feature extraction, and matching. The most important step is segmentation since it has an impact on every stage after it. Convolution Neural Networks is a very important artificial intelligence algorithm that has been widely used in many computer vision problems. One of its main features is that it is very flexible and stable and can be applied to all types of data. Inherent automatic feature extraction is also a key point because it eliminates the need for the user to really explicitly define and design what kind of features to extract, which on the other hand also eliminates the need for manual feature extraction.

Iris segmentation, iris normalisation, feature extraction, and matching are the four main modules of an iris recognition system. Segmentation is the most crucial stage because it affects all other stages after it. A crucial artificial intelligence algorithm that has been extensively applied to numerous computer vision issues is convolution neural networks. Its ability to be used with various forms of data and be extremely adaptable and stable is one of its key characteristics. The requirement for the user to very carefully describe and design what kind of features to extract is eliminated by inherent automatic feature extraction, which also eliminates the necessity for manual feature extraction.

Financial losses will rise year over year as a result of weak online security. We can use iris to provide the necessary e-security by developing precise and affordable methods as opposed to passphrases and personal identification numbers. Each person's iris texture is different, and it remains constant from birth to death. Due to its dependability and excellent security, it is widely utilised. Some classic methods for authentication include voice/face recognition, digital signatures, biometrics, graphical passwords, text-based passwords, and biometrics. This document provides examples of techniques for improving iris segmentation. Several processes, including picture capture, segmentation, feature extraction, and classification, are used to execute the iris classification. The iris picture acquisition, iris detection, iris segmentation and localization, iris normalisation, feature extraction, and feature matching processes are all included in the iris recognition system.

The use of deep learning in research has grown significantly. The system can automatically extract information, classify data, and look for trends thanks to machine learning, which doesn't require explicit programming. Examples of deep learning-based pattern recognition include face recognition and object detection. The iris recognition technology also made use of deep learning. For instance, deep learning has been used by numerous researchers to address segmentation, identification, and classification issues.

2. Literature Survey

In paper [1]C. Wang, J. Muhammad, Y. Wang, Z. He and Z. Sunproposed that Negative noise is typically present in iris photographs captured under uncooperative settings, which makes it challenging for many iris segmentation systems to function. IrisParseNet is an algorithm that is suggested as a solution to this issue. UBIRIS, MICHE, and CASIO are the datasets that were utilised.
This proposed approach is a complete iris segmentation solution, i.e., iris mask and parameterized inner and outer iris boundaries are jointly achieved by actively modelling them into a unified multi-task network. Many prior CNN-based iris segmentation methods only focused on predicting accurate iris masks by following popular semantic segmentation frameworks.
The IrisParseNet method will produce the best F1 score after all experiments, which is 94.25%.

In paper [2]Gunasekaran, E., &Muthuraman, V. introduced the algorithm whose goal is to build a brand-new real-time biometric model based on DL architecture, or HCNN model. CASIA-Iris-V3, a dataset with 2566 pictures, was employed. The major goal of the suggested approach is to pick the Region of Interest (RoI) from the iris pictures using actual iris boundary features. These classifiers produced results with an accuracy of 95.87% and a CT of 0.89 seconds.

In paper [3] Pattar,S. Y. proposed an innovative model Regarding the segmentation and classification of iris images, this approach is quite creative. This model's iris segmentation capabilities are extremely sensitive and robust. The Hamming distance classifier is used in the model.
According to the findings of the experiments, the model has 96% accuracy, 96.96% precision, 96.96% sensitivity, and 94.4% specificity. However, this method is really difficult.

In paper [4]Sardar, M., Banerjee, S., &Mitra, S. suggested iris segmentation algorithm uses convolutional networks exclusively.
First, a simple convolutional iris segmentation network algorithm is suggested.
Then, to enhance iris segmentation performance, weighted loss, multi-level feature dense fusion module, multi-scale picture training method, and generative adversarial network were applied.
The experimental findings indicate that the suggested technique performs admirably on both visible and near-infrared iris pictures.

In paper [5]Yan, Z., He, L., Wang, Y., Sun, Z., & Tan, T.proposed an algorithm in order to learn spectrum in variant characteristics by estimating device-specific bands, a novel cross-spectral iris recognition approach was presented in this article.
In iris recognition, cross-spectral recognition is still an unsolved problem. There are distinct device-specific bands between near-infrared (NIR) and visible (VIS) images in cross-spectral iris identification, which causes a distribution gap between samples from various spectra and, as a result, a considerable decrease in recognition ability.
This approach requires 3.38 milliseconds for extraction and matching in total.
The earlier recognition techniques did not take into account the effect of device-specific bands on recognition performance for the cross-spectral iris recognition job.

In paper [6]Wang, Z., Chai, J., & Xia, S. provided an end-to-end real-time system that captures the 3D head positions, the deformations of the face expressions, and the 3D eye gaze states with a single RGB camera. Our main goal is to construct a deep convolutional neural network for autonomous annotation of the iris, pupil, and eye closure. The Maximum A Posteriori framework, which we use to create the 3D eye gaze tracker, successively infers the most likely state of the 3D eye gaze in each frame. Our method uses a single RGB camera to advance the state of the art in 3D eye gaze tracking. This method is useful for capturing face and eye movement performance because it is quick, entirely automatic, and precise.

3. Data Collection

Conventional methods of gathering iris data, which include using several types of sensorslike Near Infrared Sensors and RGB specialized cameras.A public database called Multimedia University (MMU1) contains eye images for training IRIS-based biometric attendance models. IRIS is a free, searchable, up-and-downloadable collection of datasets and tools, materials, and stimuli that are used to elicit data for study into first, second, and foreign languages. IRIS patterns for each Eye are unique for every individual, and this is helpful in identifying a person.

4. Methodology

4.1 Hamming Distance

Segmentation, Feature Extraction, and Classification are the primary processes in this procedure.
• The Multimedia University (MMU) database is employed in this method's evaluation of iris segmentation.
• The solution for classification is found using the Hamming Distance method. The data are not only analysed by the Hamming distance algorithm, but also for patterns.
• The Hamming distance classifier is used to authenticate individuals.
• Hamming distance, HD, is used to compute the distance between points A and B.

$$HD = \frac{||(Code\ A \otimes Code\ B) \cap Mask\ A \cap Mask\ B||}{||Mask\ A \cap Mask\ B||}$$

Here, HD is the Hamming Distance between A and B.

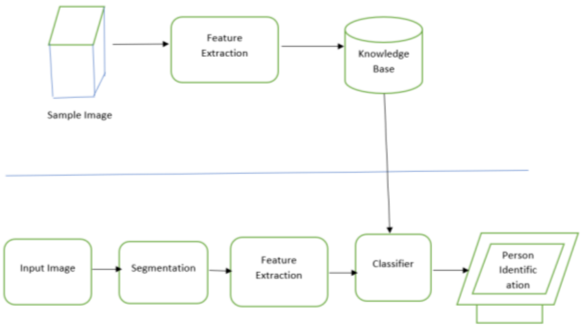

Fig 1: Hamming Distance based mechanism

4.2Selecting Region of Interest

• The suggested approach includes a number of steps, including:

1. Taking the input
2. Removal of Specific Reflections
3.Segmentation
4.Normalization
5. Image Improvement
6. Choosing ROI

However, this methodology primarily focuses on the segmentation stage.

• The segmentation involves the following substages: smoothing of the image, localization of the pupils, and localization of the irises. The iris image serves as the suggested approach's input, and its output is a noise-free Region of Interest (ROI).

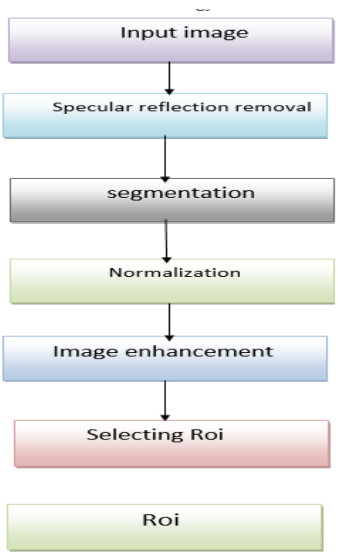

Fig 2: Flow chart of selecting Region of Interest

4.3Feature Matching

Image capture, iris segmentation, normalisation, feature encoding, feature matching, and feature identification are some of the procedures that this method entails. The segmentation locates the region of the iris in an eye image, which consists of the pupil and iris outlines. Additionally, it locates the outside (iris/sclera) and internal (pupil/iris) contours. The following step is to normalise this section. The normalising enables the conversion of the iris texture's polar coordinates from Cartesian ones using Daugman's rubber-sheet model. In order to reduce the size of iris models and increase classifier accuracy, the information in the iris image is extracted using a technique called feature extraction. Although these values are useful in categorization, these features cannot be used for picture reconstruction. Finally, matching is accomplished by contrasting thechoice is made by comparing the feature of template iris with the feature vectors of templates in the database.

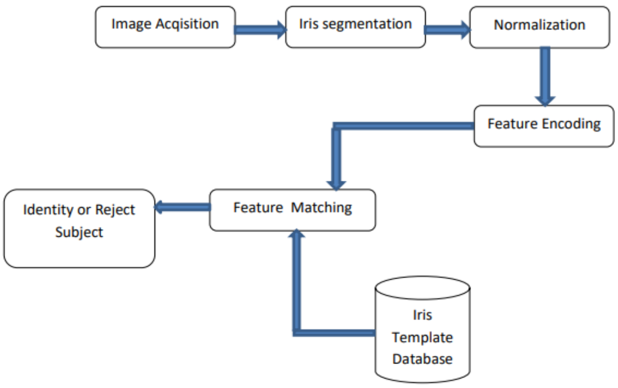

Fig 3: Feature matching mechanism

4.4K NearestNeighbors

One of the most fundamental machine learning algorithms, based on the supervised learning method, is K-Nearest Neighbor. The KNN method places the new case in the category that is most similar to the available categories based on the assumption that the new case/data and the available cases are comparable. Although the K-NN approach can be applied to classification and regression issues, classification problems are where it is most frequently used. Since the K-NN technique is non-parametric, it makes no assumptions about the underlying data. The algorithm is also referred to as a lazy learner.

Working:

Step 1: Decide on the K value.

Step 2: Determine the number K of nearby points by computing the Euclidean distance between the nearest points.

Step 4: Count the number of data points in each category among these k nearby values.

Step 5: Assign the fresh data points to the category where the neighbour count is highest.

Step 6: Our model is complete.

The ideal value for "K" cannot be determined in a specific fashion, thus we must experiment with different values to find the one that works best. K is best represented by the number 5. A relatively small number of K, such K=1 or K=2, might be noisy and cause outlier effects in the model. Although K should have large values, there may be some issues.

5. Results and Discussion

The accuracy (%) of a few deep learning and machine learning algorithms is compared.

Support Vector Machine (SVM), an algorithm that combines SVM and Artificial Neural Networks (ANN), Gradient Vector Flow (GVF), PixSegNet, FPGA, and MATLAB are the algorithms that we analysed. Comparisons based on their accuracy are given in a graph fashion in the comparison graph.

On iris image datasets like UBIRIS, CASIA, and MICHE-1, the MATLAB approach performed with great accuracy when compared to all other algorithms.

The ratio of the total number of true positives and true negatives to the total number of true +ve's, true -ve's, false +ve's, and false -ve's is known as the accuracy.

$$\text{Accuracy} = \frac{Tp+Tn}{(Tp+Tn+Fp+Fn)}$$

Comparison table of accuracies:

Name of the algorithm	Accuracy (%)
Svm	92
Svm + ANN	94
Gvf	96
Pixsegnet	94.53
HCNN	98.89
light weight CNN	99.3

Table 1: Comparison table of accuracies

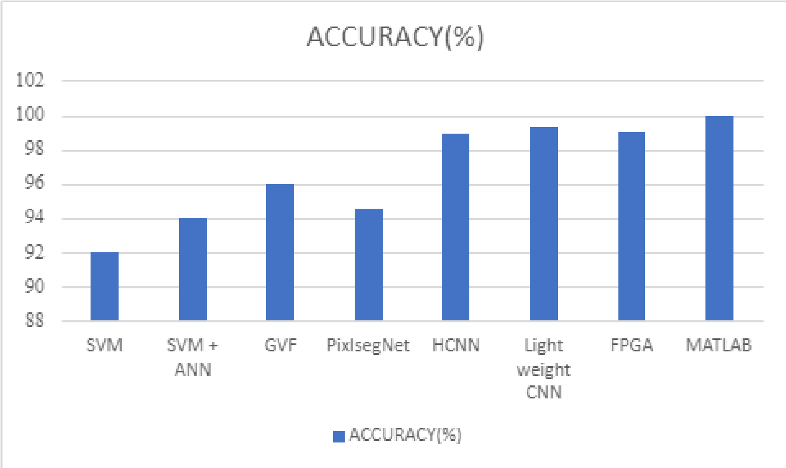

Fig 4: Graphical comparison of Accuracies

6. Conclusion

The crucial phase in the iris identification process is iris segmentation. These kinds of algorithms are used to distinguish a person based on their distinctive characteristic - iris - by extracting the pertinent data from photos to perform image segmentation. The primary goal of the research was to segment and recognise iris images. To do this, researchers used images from iris datasets like CASIO, MICHE, and UBIRIS, and then chose a region of interest (RoI) from the entire image that didn't contain any non-iris regions like eyelashes, eyelids, hair, glasses, reflections, or shadows. Support Vector Machine, an algorithm that combines SVM and artificial neural networks, MATLAB, FPGA, PixSegNet, Hierachal Neural Network method, and Light weight CNN algorithms are the most widely used algorithms.When compared to the other algorithms, the MATLAB algorithm, which had 100% accuracy, outperformed them all.

REFERENCES

[1]C. Wang, J. Muhammad, Y. Wang, Z. He and Z. Sun, "Towards Complete and Accurate Iris Segmentation Using Deep Multi-Task Attention Network for Non-Cooperative Iris Recognition," in IEEE Transactions on Information Forensics and Security, vol. 15, pp.2944-2959, 2020, Doi: 10.1109/TIFS.2020.2980791.

[2]Gunasekaran, E., &Muthuraman, V. (2020, July). Hierarchical Convolutional Neural Network based Iris Segmentation and Recognition System for Biometric Authentication. In 2020 International Conference on Communication and Signal Processing (ICCSP) (pp. 448-452). IEEE

[3] Pattar, S. Y. (2021, March). An efficient framework for iris segmentation with additional pressure term in the active contour model and classification.In 2021 International Conference on Artificial Intelligence and Smart Systems (ICAIS) (pp. 680-685).IEEE.

[4] Sardar, M., Banerjee, S., &Mitra, S. (2020). Iris segmentation using interactive deep learning. IEEE Access, 8, 219322-219330.

[5] Yan, Z., He, L., Wang, Y., Sun, Z., & Tan, T. (2021). Flexible Iris Matching Based on Spatial Feature Reconstruction. IEEE Transactions on Biometrics, Behavior, and Identity Science.

[6] Wang, Z., Chai, J., & Xia, S. (2019). Realtime and accurate 3D eye gaze capture with DCNN-based iris and pupil segmentation. IEEE transactions on visualization and computer graphics, 27(1), 190-203.

[7] Khan, T. M., Bailey, D. G., Khan, M. A., & Kong, Y. (2020). Real-time iris segmentation and its implementation on FPGA. Journal of Real-Time Image Processing, 17(5), 1089-1102.

[8]Wang, Q., Meng, X., Sun, T., & Zhang, X. (2022). A light iris segmentation network.The Visual Computer, 38(7), 2591-2601.

[9] Wei, J., Wang, Y., Li, Y., He, R., & Sun, Z. (2021). Cross-spectral Iris Recognition by Learning Device-specific Band.IEEE Transactions on Circuits and Systems for Video Technology.

[10]Huo, G., Lin, D., & Yuan, M. (2022). Iris segmentation method based on improved UNet++. Multimedia Tools and Applications, 1-21.

[11] Miron, C., Pasarica, A., Manta, V., &Timofte, R. (2022). Efficient and robust eye images iris segmentation using a lightweight U-net convolutional network. Multimedia Tools and Applications, 81(11), 14961-14977.

[12] Ridha, J. A., & Saud, J. H. (2020, April). Iris Segmentation Approach Based on Adaptive Threshold Value and Circular Hough Transform. In 2020 International Conference on Computer Science and Software Engineering (CSASE) (pp. 32-37).IEEE.

[13] Jalilian, E., Karakaya, M., &Uhl, A. (2021). CNN- based off- angle iris segmentation and recognition. IET Biometrics, 10(5), 518-535.

[14] Ohmaid, H., Eddarouich, S., Bourouhou, A., &Timouyas, M. (2020). Iris segmentation using a new unsupervised neural approach.IAES International Journal of Artificial Intelligence, 9(1), 58.

[15] Chen, Y., Wang, W., Zeng, Z., & Wang, Y. (2019). An adaptive CNNs technology for robust iris segmentation. IEEE Access, 7, 64517-64532.