Iris Recognition and the Use of Artificial Intelligence in Biometrics

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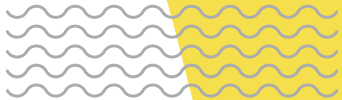
Introduction



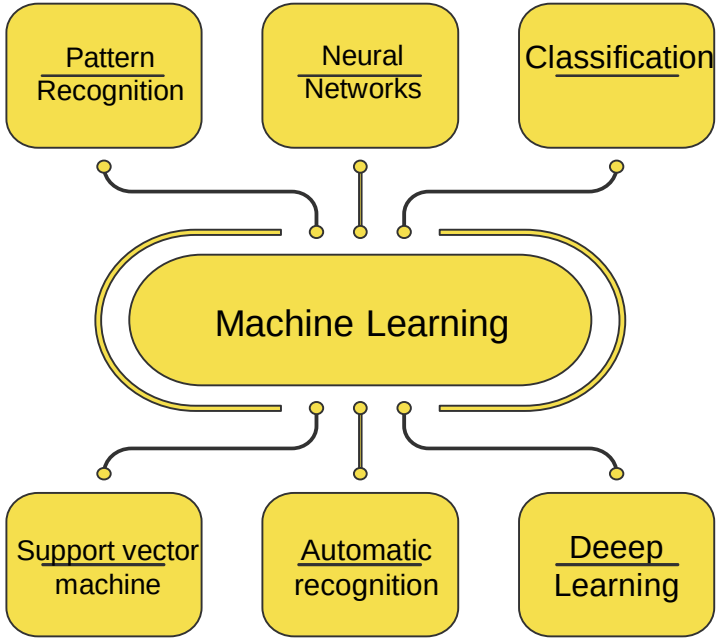
Artificial intelligence gradually takes place in our lives and changes the world around us. As we have seen in the movie “Minority Report” and in recent discoveries over the years, a future which seems so technologically advanced and catered to our specific desires and needs by using biometric authentication is not as far as one might think.

Minority Report Iris Scan

02
The IRS

What is Iris recognition?

Iris Recognition is an automated method of biometrics identification. It falls under the AI domain of learning, specifically the subdomain of machine learning. The mathematical pattern-recognition system works by extracting key points in the image of the iris, then encoding it into a digital pattern and matching it to a certain individual.


Pattern Recognition
Neural Networks
Classification
Machine Learning
Support vector machine
Automatic recognition
Deeep Learning

That sounds complicated….

And it is!

Successful iris recognition is achieved in many ways. Pattern recognition and classification are the main methods used in visual identification.
An Iris Recognition System (IRS), whether using traditional or deep learning techniques, generally consists of seven main phases (Malgheet et al., 2021)
These are:

1. Image Acquisition
2. Pre-processing
3. Iris Segmentation
4. Iris Normalization
5. Feature Extraction
6. Feature Selection
7. Classification

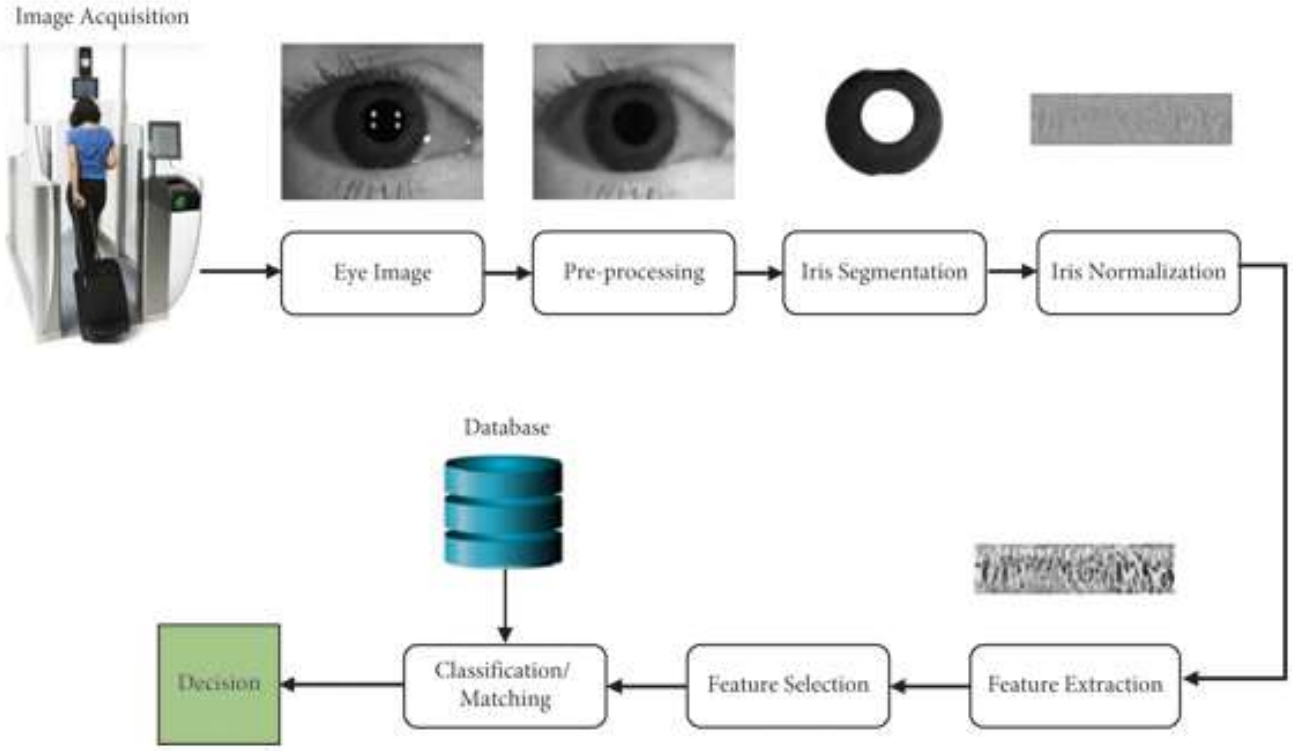


Image Acquisition
Eye Image
Pre-processing
Iris Segmentation
Iris Normalization
Database
Decision
Classification/
Matching
Feature Selection
Feature Extraction

1. Image Acquisition

Typically, an iris image is taken using a near-infrared spectrum (NIR). The images obtained by the NIR spectrum tend to interact with the complex texture of the iris region, instead of the pigmentation, while being less prone to noise than other models used for iris image acquisition (Malgheet et al., 2021). This means that even darker-colored iris textures can be captured, therefore increasing the efficiency.

2. Pre-processing

Typically, iris images obtained suffer from different types of noise such as closing caused by eyelids or eyelashes or lighting or illumination. Removing these types of noise will enhance the performance accuracy of the IRS.

We will analyse one methods of pre-processing iris images:

- Hough Transform method

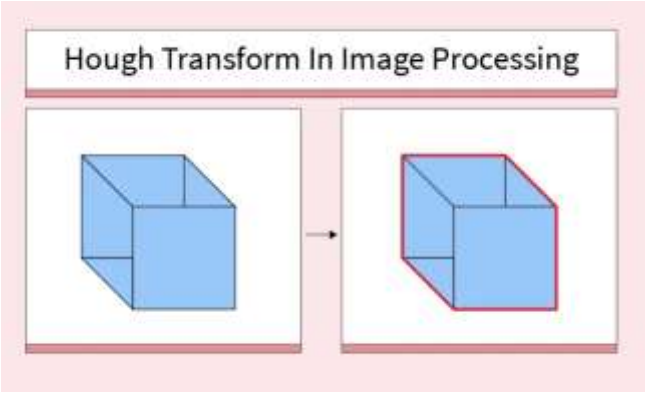


Image taken from: Scaler Topics

3. Iris Segmentation

In the segmentation phase, the iris part of the eye is extracted and removed from the non-useful parts. Iris recognition techniques depend on the quality of the features of the region that has been segmented. Most failures in this system are due to inaccurate segmentation.

Input image

Image classification

Cat

Object localization

A single bounding box

Object detection

Multiple bounding boxes

Semantic segmentation

One mask for all objects with the same class

Instance segmentation

Multiple masks

4. Iris Normalization

Normalization refers to the operation of converting the circular pattern of the segmented iris region into a rectangular pattern to mathematically analyze and pinpoint each key feature in the image.
The most extensively used method for iris normalisation is Daugman's rubber-sheet model, which turns the circular iris region into a fixed sized rectangular block (Daugman, 1993).

5. Feature extraction

The feature extraction phase is the most critical part of the IRS in order to achieve high accuracy. During this part of the process, the amount of data is reduced and simplified.

6. Feature selection

The basic goals of feature selection are to reduce computation time and space required to run algorithms, to improve the classifier by removing noisy or unneeded features, and to choose features that may be related to a specific problem.

7. Classification

In the classification phase, the level of resemblance between the test samples and the sample in the database is compared. Of course, a full match is quite impossible. However, the IRS is mostly based on an approximate rate.

Let’s have a look at a real-life example of Iris Identification being used

https://www.dhs.gov/xlibrary/videos/18_0727_st_Biotech_

Clip provided by the U.S.A’s department of Homeland Security.

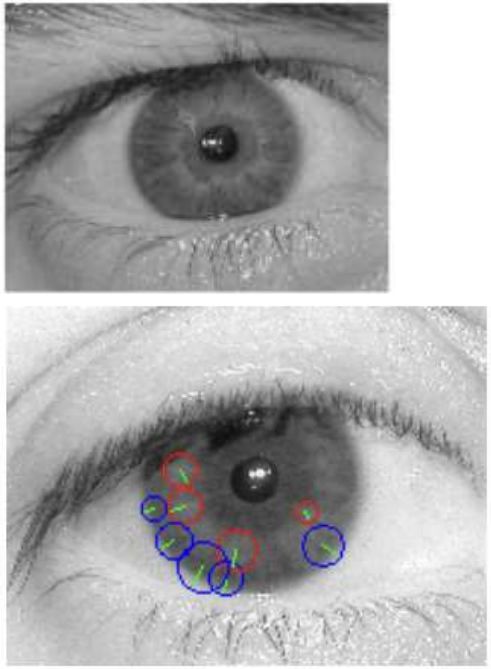
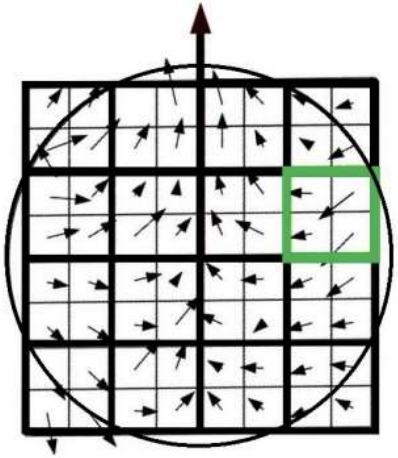
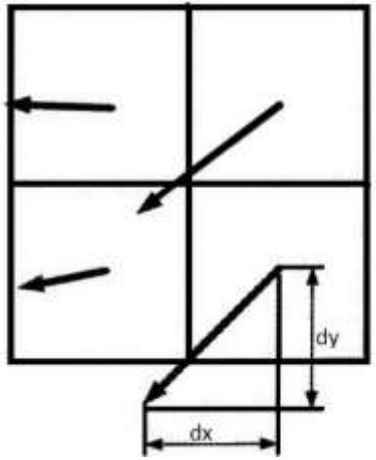


Figure 6: Key points detected





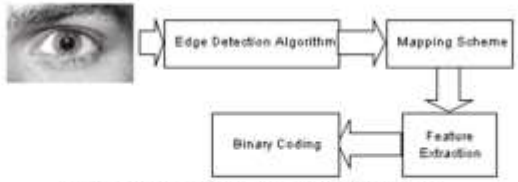
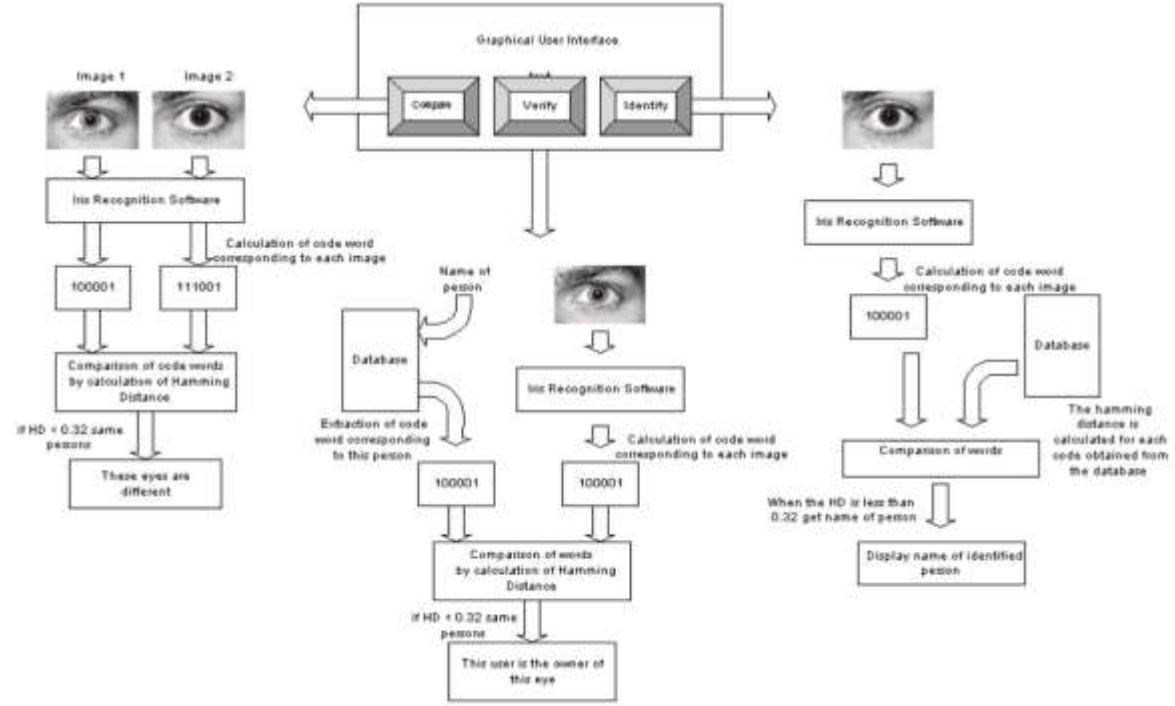


Figure 7.Flow Chart of Iris Recogniton



03 Is it feasible?

Iris recognition feasibility

Strenghts

1. **Uniqueness:** Each person's iris patterns are highly unique, even between identical twins, which enhances its effectiveness in distinguishing individuals.
2. **Resistance to Forgery:** The complex and intricate patterns of the iris make it difficult to forge or replicate artificially.
3. **Speed:** Iris recognition can be performed quickly, allowing for efficient user authentication and access control.
4. **Non-Invasive:** Iris recognition is non-invasive and does not require physical contact, making it more hygienic compared to some other biometric methods like fingerprint recognition.

Weaknesses

1. **Privacy Concerns:** The use of iris recognition raises privacy concerns, as it involves the collection of highly sensitive biometric data. Proper security measures are essential to protect this data from unauthorized access.
2. **Cost:** Implementing iris recognition systems can be costly, including the expense of specialized hardware and software, which may limit its adoption in some applications.
3. **Illumination and Environmental Factors:** Poor lighting conditions, reflections, and other environmental factors can affect the quality of iris images, potentially leading to recognition failures.
4. **Iris Capture Challenges:** Capturing a clear and high-quality iris image can be challenging, especially if the subject has eye conditions like cataracts or if they are unable to cooperate effectively.

Required technological advancements

To achieve total iris recognition implementation in society, several key advancements are needed. These include improving accuracy and robustness, reducing costs, enhancing privacy and security measures, creating user-friendly interfaces, promoting interoperability, adapting to diverse environments, efficient database management, and ensuring ethical and legal frameworks. Real-time processing, advanced data transmission, standardized testing, user education, and international collaboration are also crucial components. Achieving these advancements will enable the widespread adoption of iris recognition technology while addressing privacy, security, and usability concerns.

Real-life scenario

In a study by Anne et al., titled "Feasibility and acceptability of an iris biometric system for unique patient identification in routine HIV services in Kenya," iris images were captured and processed to improve patient identification in HIV program data. Over 55 weeks, just 0.1% of patients declined iris scanning, citing privacy concerns. These results demonstrate the feasibility and acceptance of iris recognition in Kenyan healthcare. Scaling up this technology could greatly enhance patient identification and disease surveillance efforts.

04 Ethical Aspects

Morality and Conclusion

The most important concern of this biometric verification is privacy and data security, as iris scans involve the acquisition of extremely sensitive biometric data. It is critical to implement strong protections to secure this data from unauthorised access and breaches. Another ethical issue is informed consent, with individuals needing clear knowledge about how their iris data will be used, who will have access to it, and the chance to opt-out if they so desire.

Recently, the European Parliament has banned the use of facial recognition due to concerns about its invasiveness. This could also be the fate of iris recognition. To properly manage these ethical problems, public awareness, education, and appropriate practices are required.

Thank you for your attention!

Resources

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