Iris Recognition System

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Abstract

Iris recognition is a biometric identification system that uses the distinctive patterns of the human iris to verify or identify individuals. This documentation gives a detail of the design and implementation of an iris recognition system that is based entirely on image processing techniques. In order to precisely identify people based on the distinctive features of their irises, the system goes through a number of processes, including image acquisition, preprocessing, feature extraction, and matching. The system achieves reliable performance by focusing solely on image processing, without the requirement for machine learning or artificial intelligence. The paper aims to serve as a thorough manual for the system's development and deployment, emphasizing its applicability and efficacy in biometric identification.

1 Introduction

Unlike other biometric traits like fingerprints or facial recognition, the iris pattern remains constant throughout an individual's life, making it an excellent identification tool. As image processing and machine learning techniques have advanced, iris identification systems have become more accurate and accessible. This paper suggests an iris recognition system that uses color histograms to reflect the unique features of the iris in order to facilitate accurate and efficient identification.

2 Dataset

The dataset link: Iris Images Dataset on Kaggle.

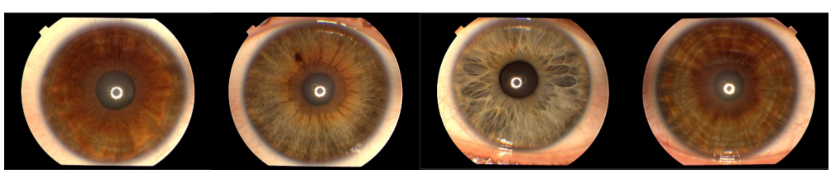

Figure 1: Example of an Iris Images from the Dataset

3 Methodology

This research uses a set of procedures to identify an individual based on histograms of the iris region of the eye. Preprocessing, histogram computation, recognition, evaluation and results are the various components of the methodology. The steps are described in detail below:

3.1 Image Preprocessing

The method starts with image preprocessing to extract useful information from the input image. OpenCV reads the incoming photographs and resizes them to a standard size of 256×256 pixels. The resizing ensures that the images are uniform for further analysis.

The images are then converted to the HSV color system since it provides better color separation than the RGB color space. In the HSV model, the Hue channel is essential for gathering color information from the iris area. After recovering the Hue channel, a circular mask is used to focus on the iris region, assuming it is centered in the enlarged image. Depending on the actual iris size, a circular mask with a radius of 60 pixels is employed.

Finally, the histogram of the Hue channel within the masked iris region is calculated. The histogram represents the distribution of color intensities in the iris region and is normalized to make it comparable across different images.

3.2 Histogram Computation

Next, each person's average Hue histogram is determined. A person is represented by each of the files that make up the collection. Each folder contains images of the left and right eyes. For each person, the following steps are taken:

- The masked Hue channel histograms are calculated for both the left and right eye images.
- A single representative histogram that depicts the normal color distribution of the individual's iris region is created by averaging the histograms.

The average histogram of each individual is stored in a dictionary, with the individual's name serving as the key and the average histogram as the value. This dictionary is saved for subsequent use using Python's `pickle` module.

3.3 Person Recognition

The average histograms of each individual stored in the previously generated `average_histograms.pkl` file for the recognition task are compared to the preprocessed test image. The comparison is made using histogram correlation, which measures the degree of similarity between two histograms. This comparison is carried out using the `cv2.HISTCMP_CORREL` method and the OpenCV function `cv2.compareHist`.

The test image is prepared in the same ways as the training photos, which include masking, HSV conversion, and resizing. It computes the histogram of the iris region of the test image and compares it with the average histograms of all people to determine how similar they are. The person in the image is identified as the one whose histogram most closely matches the histogram of the test image.

3.4 Evaluation and Accuracy

After the recognition stage, the actual and expected labels are compared to assess the system's performance. The test dataset used in the evaluation includes pictures of the left and right eyes of several individuals. The `accuracy_score` and `confusion_matrix` functions from the `sklearn.metrics` module are used to compute the confusion matrix and accuracy score.

By displaying the amount of accurate and inaccurate predictions for each person, the confusion matrix offers a thorough summary of the model's efficacy for each individual. The accuracy score shows the percentage of accurate predictions among all test pictures, indicating the overall performance of the system.

4 Testing and Results

A test dataset comprising photographs of 15 individuals was used to assess the iris recognition system's performance. Images of each participant's left and right eyes are included in the dataset. The system uses basic image processing techniques to successfully identify people based on their distinct iris patterns.

On the test dataset, the system's total accuracy was **0.97**. This great accuracy, which enables the system to discriminate between different iris patterns, shows how successful the image processing algorithms are. The system's resilience is further demonstrated by the correlation coefficient between the training and testing results, which highlights the system's consistency and dependability.