Iris Recognition System using SIFT Feature Matching

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***Abstract*— Iris recognition is a form of biometric technology in which visible and near-infrared light is used to take a high-contrast image of a person's iris. Iris scanning measures the iris pattern uniqueness since every person has a unique iris of a specific shape and format. In this paper, a model for iris detection and recognition using Scale-invariant feature transform and BFMatcher is introduced. The process of iris segmentation and detection is implemented using Canny Edge Detector and Hough Transform given the knowledge that irises have approximately a circular shape. The iris recognition process takes place prior to extracting iris location from the eye image. The recognition process is implemented using SIFT to extract local descriptors and then matching between iris images to figure out whether they are matched or not. The iris recognition system was tested on well-known datasets: CASIA Iris 1 and UBIRIS Version 1.**

Keywords — Iris, SIFT, BFMatch, Hough Transform, Canny Edge Detector

I. INTRODUCTION

Recently, iris recognition systems became widely used in many biometric pattern recognition applications especially in security systems (1). The importance of depending on this technology is that it leads to identification with a very high accuracy due to the uniqueness property of irises (2). The iris has random morphogenesis which makes each person has a unique pattern (3). Irises are not only considered as unique properties, but they can also give a higher accuracy than other human characteristics like fingerprints and handwritings. Accordingly, a lot of governments and institutions are currently using this biometric technology in their security systems [36]. This paper proposes a model to detect and match irises. The proposed model can be used in security systems for authentication, in schools and universities for attendance, etc. The model uses Canny Edge Detector and Hough Transform to separate between different parts of eye (pupil, iris, and sclera). After extracting iris, SIFT is used to find local features that describe the iris of a specific person. Finally, BFMatch method is used to match between features of 2 irises and decide whether they belong to the same person or not. The model is tested using samples from 2 datasets (CASIA 1, and UBIRIS 1) and showed high accuracy.

II. MODEL OVERVIEW AND DISCUSSION

The model is designed such that it takes two images as inputs. Each of the 2 images will pass through 3 stages: Iris Detection, Iris Segmentation, SIFT Features. The outputs from the previously mentioned 3 stages will pass through the last stage in which they will be compared and matched with each other using BFMatch. Finally, the model will decide whether the 2 input images belong to the same person or not. The model can be generalized for N users so that it can store the feature vectors of the N users annotated by a unique ID. For any upcoming image, the user will be requested to enter his/her ID before authentication using iris. Based on the entered ID, the new image will be compared and matched with only one image, the one that was previously annotated by the entered ID.

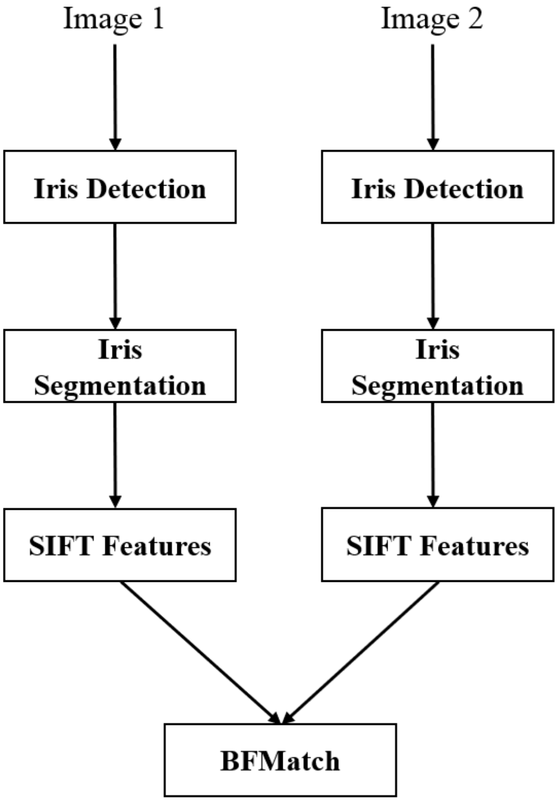

Figure (1): Model Overview

A. Iris Detection

In this stage, the model takes an input image resulted from iris scanning, which is a technology that uses infrared light to get a high contrast image of person's iris. Then, the model tries to get the iris's boundaries. As shown in Figure (2), the iris lies between both pupil and sclera. Accordingly, this stage aims to only pass the iris that carries unique information.

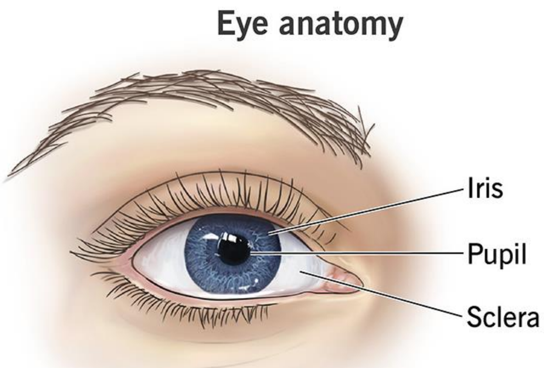

Figure (2): Eye Anatomy

The following figures show some examples of the input images to Iris Detection Stage.

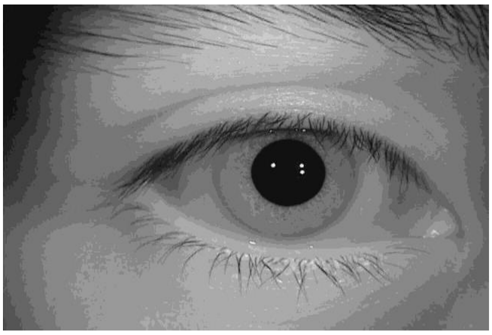

Figure (3): Input Image Sample

- Pupil Circle is found using Hough Transform.
- Median Filter is used to remove any salt and paper noise at the pupil since its dominant color is black.
- Threshold Filter is applied to binarize the colors in the image (Black and White only).
- Different thresholds are set such that Hough transform will be able to detect the pupil's circles.
- Hough Transform returns 3 values (Center X-coordinate, Center Y-coordinate, Radius).
- All obtained values from all iterations are averaged to get the mean value.

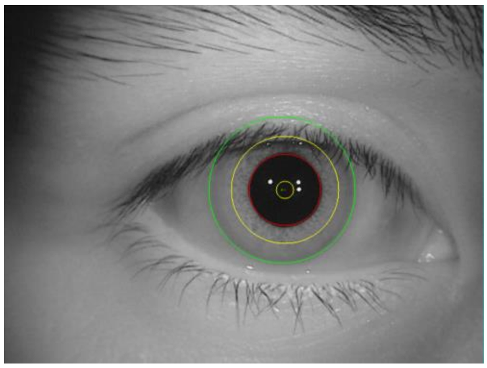

Figure (4): After Iris Detection

B. *Iris Segmetation*

In this stage, the model takes the locations and circles of both iris and pupils to extract the iris out of the image.

- Model uses a Mask of 1’s at the location of iris.
- The mask is obtained using the circles of both pupils and iris.
- Bit-wise AND is used to segment the iris from the image. Figure (5)
- Histogram Equalization is used for color enhancement in order to get the utmost details from the iris. Figure (6)

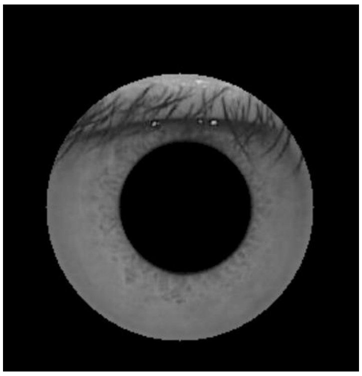

Figure (5): Iris Segmentation

Figure (6): Histogram Equalization

C. *SIFT Features*

The Scale-Invariant Feature Transform (SIFT) SIFT detector extracts from an image some frames to detect the region of interest such that there is a consistency with some variations that will be filtered out in future. The descriptor associates to the regions a signature which identifies their appearance compactly and it is robust to the noise more robustly after the image processing. Firstly, extracting key points frame which most like comes after edge detection, then find the distances to apply further filtration.

For each descriptor function used to find the closest descriptor using L2 norm for the difference between them. The closest descriptor matches and the distance between the pair is then stored to use these vectors.

Matches also can be filtered for uniqueness by passing a third parameter to which specifies a threshold. Here, the uniqueness of a pair is measured as the ratio of the distance between the best matching key point and the distance to the second best one.

Detector parameters:

There are two main parameters that can control SIFT detector:

- Peak Threshold.
- Non-Edge Threshold.

The peak threshold filters peaks of the DoG scale space that are too small.

Algorithm:

Resizing the image to get an octave as shown in Figure (7), to assure scale invariance. By tuning the threshold filter using DoG on all the octaves to get the key points, Shown in Figure (8). divide the 4x4 vector to 4x4 which gives as a total 256 cell and compute the votes for the gradients, choosing the most voted direction as the gradient for this pixel, as shown in Figure (9).

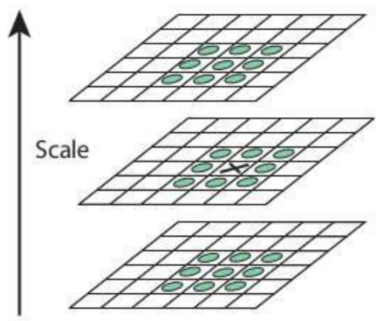

Figure (7): Scaled Images

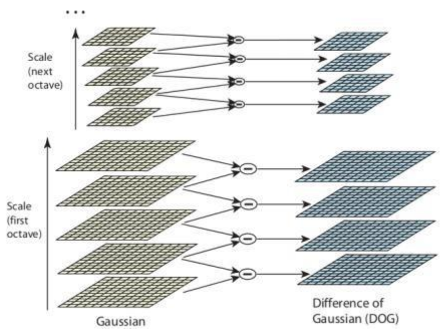

Figure (8): Apply DoG to Scaled and Blurred Images

The following figure shows the output of SIFT Stage.

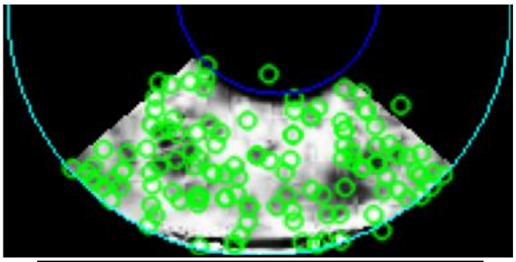

Figure (9): SIFT Output

D. *BFMatch*

The algorithm used to test if the matching points is the Braute-force matching with SIFT Descriptors. This time, we will use Braute-force with KNN to get k best matches. In this example, we will take k=2 so that we can apply:

- Ratio Test.
- Applying ratio between output distances out of bf.knnMatches(), ratio commonly used = 0.8.
- Cosine Difference: Applying cosine difference for similarity between vertical angles of query and trained pictures.
- Applying median filtering: Using median technique and tuning the standard deviation, σ=100 as standard deviation for vertical angle and σ=0.15 as standard deviation distances.

Since Braute-force technique is used for the finite sample space problem. The algorithm Starting from an initial state and initial input -may be initialized with zeros- the instructions describe a computation that, when executed, proceeds through a finite number of states, with the right termination the algorithm will terminate producing the output which is the matching pixels in our problem. Braute-force compares all the points of interest and by using KNN in our problem having the 2-NN to apply the above-mentioned techniques to filter out the matched points.

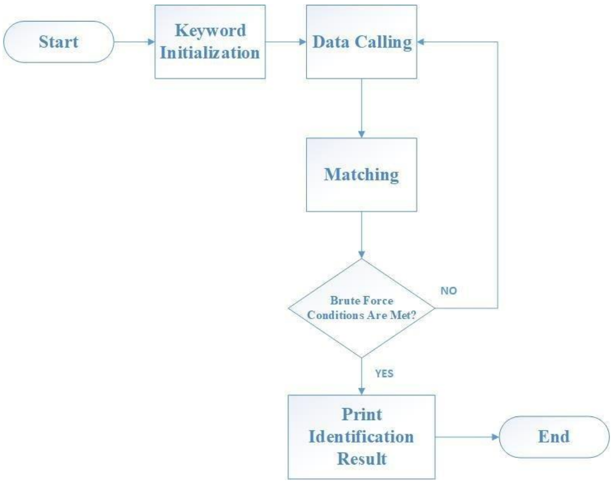

Figure (10): Braute-force Matching

The following figure shows the output result from this stage.

Figure (11): Braute-force Matching

E. Refrences

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