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A Review of Iris Recognition System used for feature recognition and different techniques

Vijay Prakash sharma[1], Sadhna Mishra[2], Vineet Richhariya[3]
[1]M.Tech. Research Scholar, [2]Professor, [3]Professor & Head (LNCT, Bhopal)
[1]sharmavijayprakash@gmail.com, [2]sadhnamanit@yahoo.com, [3]vineet_rich@yahoo.com

Abstract: The biometric person authentication technique based on the pattern of the human iris is well suited to be applied to any access control system requiring a high level of security. Iris recognition is a proven, accurate means to identify people. Iris recognition system includes the preprocessing system, segmentation, features extraction and recognition. Especially we focus on image segmentation and statistical feature extraction for iris recognition process. The iris recognition system is highly depending on segmentation. A good number of identification systems based on behavioral characteristics (such as voice, handwriting, signature, speech, and keystroke) and physical characteristics (such as face, finger print iris etc) are being employed for identification of an individual. A compare has been made between these two techniques using FAR analysis, FRR analysis, memory requirement and algorithmic complexity.

Keywords: FAR, FRR, iris recognition, statistical features, feature vectors, edge detection.

1. INTRODUCTION

Biometric identification or verification of identity is currently a very active field of research. To control the access the secure material, a reliable and accurate personal identification is required. Many applications that require higher degree of confidence concerning the personal identification of the people, such as banking, ATM, computer network access or physical access to secure facility are use of paper or plastic identity cards, or alpha-numeric passwords. Biometric solutions address these essential problems, because an individual's biometric data is unique and cannot be transferred. Biometrics is automated methods for identifying a person or verifying the identity of a person based on physiological or behavioral. Examples of physiological characteristics are iris recognition, hand or finger images, facial characteristics etc.

This paper presents a straight forward approach for segmenting the iris patterns. The iris is the colored portion of the eye surrounding the pupil. Like fingerprints, iris patterns are more complex and uniquely identify individuals. Examples of iris characteristics include crypts, which are oval-shaped areas within the iris; pigmented rings that surround the pupil; furrow contractions, which are radial and concentric bands around the pupil; and pigmented spots on the iris, also called nevi. The heritability of various types of iris patterns ranges between 70-95%, meaning that genetics contribute strongly to these traits. For examples, a signature is unfair by both controllable actions and less psychological factors, and speech pattern is unfair by current emotional state, whereas fingerprint template is unique. However all physiology based biometric don’t offer satisfactory recognition rates (false acceptance rates and false reject rates, referenced as FAR and FRR). The personal identity authentication systems based on iris recognition are reputed to be the most reliable among all biometric methods.

Compared to fingerprint, iris is protected from the external environment behind the cornea and the eyelid. No subject to harmful effects of aging, the small scale radial features of the iris remain stable and fixed from about one year of age during life. In this paper, we implemented the iris recognition system by composing the following four steps. The first step is preprocessing. In that case, the pictures’ size and type are manipulated in order subsequently the processing. Once the preprocessing step is completed, it is necessary to detect the images. After that, we can extract the surface of the iris. Finally, we compare the coded image with the already coded iris in order to find a match an impostor.

1.1 Overview

Today, biometric recognition is [1] a common and reliable technique to authenticate the identity of a person based on physiological or behavioral characteristics. A physiological characteristic is stable physical characteristics, such as fingerprint, iris pattern, face, hand silhouette, etc. This kind of measurement is basically unchanging and permanent without significant duress. A behavioral characteristic is more an expression of an individual’s psychological makeup as signature, speech pattern, voice etc. The level of intra-personal variation in a physical characteristic is smaller than a behavioral characteristic. For examples, a signature is unfair by both controllable actions and less psychological factors, and speech pattern is unfair by current emotional state, whereas fingerprint template is unique. However all physiology-based biometrics doesn’t offer acceptable recognition rates (false acceptance and false reject rates, referenced as FAR and FRR). The personal identity authentication systems based on iris recognition are reputed to be the most reliable among all biometric methods. Compared to fingerprint, iris is protected from the external environment behind the cornea and the eyelid.

1.2 Background

The French ophthalmologist Alphonse Bertillon seems to be the first to propose the use of iris pattern (color) as a basis for personal identification. In 1981, after reading many scientific reports describing the iris great variation, Flom and San Francisco ophthalmologist Aran Safir suggested also using the iris as the basis for a biometric. In 1987, they began collaborating with computer scientist John Daugman of Cambridge University in England to develop iris identification software who published his first promising results in 1992. Later on a little similar works have been investigated, such as R. Wildes', W. Boles' and R. Sanchez - Reillo's systems, which differ both in the iris features representation (iris signature) and pattern matching algorithms. R. Wildes' solution includes a Hough transform for iris localization, (ii) Laplacian pyramid multi-scale decomposition) to represent distinctive spatial characteristics of the human iris, and (iii) modified normalized correlation for matching process. W. Boles' prototype operates in building (a) a one-dimensional representation of the gray level profiles of the iris followed by obtaining the wavelet transform zero-crossings of the resulting representation, and (b) original dissimilarity functions that enable pertinent information selection for efficient matching computation.

1.2.1 Image preprocessing

Preprocessing in IRS means to convert the image of an eye into a form, from where the desired features can be extracted and used for identification of an individual from the available database. Here, image preprocessing is divided into three processes, namely, iris localization, iris normalization and image enhancement. In iris localization, one detects the inner and outer boundaries of iris, and removes the eye lashes of eye lids that may cover iris region. Iris normalization is required to convert the iris image to polar coordinates from Cartesian coordinates.

1.2.2 Iris Recognition

Recognition process has been carried out using template matching by various researchers. In template matching, user's iris template is compared with the templates from the database using a matching metric. The matching metric gives different range of values when [2] a given iris template is compared with other stored templates. Based upon these range of values, a decision is taken about the identity of a person, i.e., the person is an authentic one or not.

1.3.3 Feature Extraction

After preprocessing, one has to take up the task of feature extraction. Once the normalized image is obtained, various techniques such as Gabor filters, Wavelet transform, Hilbert transform, shape based, cumulative SUM based change analysis etc. can be employed to extract the significant features from the iris image by creating iris template. Employed feature extraction techniques on the normalized iris image whereas the features without normalizing the iris image [1]

2. FEATURE EXTRACTION

One of the most interesting aspects of the world is that it can be considered to be made up of patterns. A pattern is basically an arrangement. It is characterized by the organize of the elements of which it is made, rather than by the intrinsic [3] nature of these elements. This definition summarizes our purpose in this part. This step is responsible of extracting the patterns of the iris taking into account the correlation between adjacent pixels.

2.1 Feature Extraction without normalization

After detecting the inner and outer edges of iris and pupil, the center of pupil and inner edges are used to draw number.

3. SEGMENTATION

Segmentation process is the most important and difficult steps in the image processing system. It means the quality of image processing heavily depends on the quality of segmentation process.

Figure 1. Original image

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In this process, we applied Sobel edge detector. By using this detector, we can easily observe the gradient value. If global threshold value is used on that gradient image, the gradient values with the potential [3] edge will be missing. In order to avoid that effect we can use local threshold in the area of interest. Gabor filtering is also a good solution to that problem as well as a preprocessing tool for quality edge detection.

4. STATISTICAL FEATURES EXTRACTION

After edge detection, we get inner and outer edges of iris as well as pupils area. Using the center of pupil and inner edge, we can draw various sizes of lines like concentric circles along which statistical features are computed. Following statistical features are considered in this paper for iris recognition process:-

(a) mean
(b) median
(c) mode
(d) variance and
(e) standard deviation

4.1 Mean

For a data set, the arithmetic mean is equal to the sum of the values divided by the number of values. The arithmetic mean of a set of numbers x_1, x_2, ..., x_n is typically denoted by x', pronounced "x bar" if the data set were based on a series of observations obtained by sampling from a statistical population.
The arithmetic mean is the "standard" average, often simply called the "mean".

$$x' = \frac{1}{n}\sum_{i=1}^{n} xi$$

4.2 Median

Median is described as the numerical value separating the higher half from the lower half of a sample. The median of a finite list of numbers can be found by arranging all the interpretation from lowest value to highest value and picking the middle one. If there is an even number of interpretation, then there is no single middle value; the median is then usually defined to be the mean of the two middle values.
A median is defined on one-dimensional data, and is independent of any distance metric. On the other hand A geometric median, is defined in any number of dimensions.

4.3 Mode

The mode is the value that appears most repeatedly in a set of data. Like the statistical [4] mean and median, the mode is a way of expressing, in a single number, important information about a random variable. The numerical value of the mode is the same as the mean and median in a normal distribution and it may be very different in highly skewed distributions.
The mode is not necessary unique, since the same highest frequency may be attained at different values. The most excessive case occurs in uniform distributions, where all values arise equally frequently.

4.4 Variance

The distribution of both the sample mean and the sample median were [4] determined by Laplace. The distribution of the sample median from a population with a density function f(x) is asymptotically normal with mean m and variance.

$$\frac{1}{4nf(m)2}$$

The **variance** is a measure of how far a set of numbers is sizeable. It is one of several descriptors of a probability distribution, describing how far the numbers lie from the mean value (expected value). In particular, the variance is one of the moments of a distribution. In that context, it forms part of a efficient approach to difference between probability distributions. While some other approaches have been developed, those based on moments are beneficial in terms of mathematical and computational simplicity.

Standard Deviation

Standard deviation (represented by the symbol sigma, σ) shows how much variation or "dispersion" exists from the average (mean, or expected value). A low standard [3] deviation indicates that the data points tend to be very close to the mean; high standard deviation indicates that the data points are spread out over a large range of values. The standard deviation of a random variable, statistical population, data set, or probability distribution is the square root of its variance. It is algebraically simpler though practically less

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robust than the average absolute deviation. A functional property of standard deviation is that, it is dissimilar of variance and expressed in the same units as the data.

5. MATCHING

Pattern matching technique is applied after feature extraction process of iris [1] patterns. Database of iris templates is created for both feature extraction methods. In this paper, similarity of two iris codes is obtained using hamming distance. Lower hamming distance means higher similarity. Hamming distance between Boolean vector of test image and iris templates stored in the database is calculated. Boolean vector for method of feature extraction without normalization is formed by taking difference between features of the adjacent circles and threshold the difference. Similarly, Boolean vector in case of method with normalization is formed by comparing the cumulative sum of adjacent group. If slope of cumulative sum change is upward the iris code is set to one otherwise to zero.

CONCLUSION

This paper can enhance the performance of iris recognition system by using the statistical features. In which we tested the comparison of two iris patterns by using Hamming distance. We have effectively developed this new Iris Recognition system accomplished of comparing two iris images. This identification system is quite uncomplicated requiring few components and effective enough to be integrated within security systems that require an identity check. Judging by the clear distinctiveness of the iris patterns we can expect iris recognition systems to become the leading technology in identity verification. The experimental results show that the outputs of this paper are acceptable. It will be better if more statistical features are used such as pixels correlation in the iris area. Implementation [7] of iris recognition system with normalization and without normalization and their comparative study shows that both methods have their own advantages and disadvantages. The algorithmic complexity of iris recognition system without normalization is lesser than method with normalization.

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