Iris Recognition System using canny edge detection for Biometric Identification

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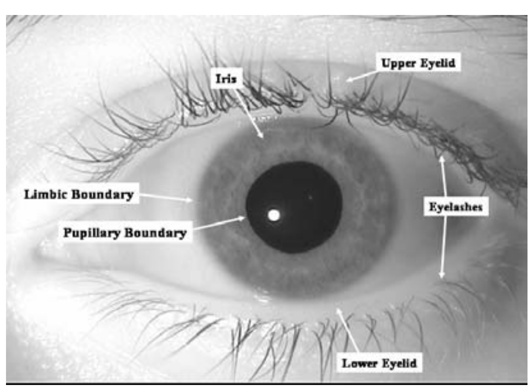
Abstract— A biometric system provides automatic identification of an individual based on a unique feature or characteristic possessed by the individual. Iris recognition is regarded as the most reliable and accurate biometric identification system available. Most commercial iris recognition systems use patented algorithms developed by Daugman, and these algorithms are able to produce perfect recognition rates. Especially it focuses on image segmentation and feature extraction for iris recognition process. The performance of iris recognition system highly depends on edge detection. The Canny Edge Detector is one of the most commonly used image processing tools, detecting edges in a very robust manner. For instance, even an effective feature extraction method would not be able to obtain useful information from an iris image that is not segmented properly. This paper presents a straightforward approach for segmenting the iris patterns. The used method determines an automated global threshold and the pupil center. Experiments are performed using iris images obtained from CASIA database (Institute of Automation, Chinese Academy of Sciences) and Matlab application for its easy and efficient tools in image manipulation.

Keywords- Iris recognition, segmentation, image processing, canny edge detection.

I. INTRODUCTION

Biometrics involves recognizing individuals based on the features derived from their Physiological and behavioral characteristics. Biometric systems provide reliable recognition schemes to determine or confirm the individual identity. A higher degree of confidence can be achieved by using unique physical or behavioral characteristics to identify a person; this is biometrics. A physiological characteristic is relatively stable physical characteristics, such as fingerprint, iris pattern, facial feature, hand silhouette, etc. This kind of measurement is basically unchanging and unalterable without significant duress. Applications of these systems include computer systems security, e-banking, credit card, access to buildings in a secure way. Here the person or object itself is a password. User verification systems that use a single Biometric indicator are disturbed by noisy data, restricted degrees of freedom and error rates. Multi biometric systems tries to overcome these drawbacks by providing multiple evidences to the same identity hence the performance may be increased. The automated personal identity Authentication systems based on iris recognition are reputed to be the most reliable among all biometric methods: we consider that the probability of finding two people with identical iris pattern is almost zero. The uniqueness of iris is such that even the left and right eye of the same individual is very different [1] [2]. That's why iris recognition technology is becoming an important biometric solution for people identification Compared to fingerprint, iris is protected from the external environment behind the cornea and the eyelid. No subject to deleterious effects of aging, the small-scale radial features of the iris remain stable and fixed from about one year of age throughout life. In this paper, we implemented the iris recognition system by composing the following four steps. The first step consists of preprocessing. Then, the pictures' size and type are manipulated in order to be able subsequently to process them. Once the preprocessing step is achieved, it is necessary to detect the images[3]. After that, we can extract the texture of the iris. Finally, we compare the coded image with the already coded iris in order to find a match an impostor. These procedures can be viewed as depicted in fig.1



A sample iris image is shown in Fig. 1. Since it has a Circular shape when the iris is orthogonal to the sensor, iris recognition algorithms typically convert the pixels of the iris to polar coordinates for further processing. An important part of this type of algorithm is to determine which pixels are actually on the iris, effectively removing those pixels that represent the pupil, eyelids and eyelashes, as well as those pixels that are the result of reflections [4]. In this algorithm, the locations of the pupil and upper and lower eyelids are determined first using edge detection. This is performed after the original iris image has been down sampled by a factor of two in each direction. The best edge results came using the canny method [5].The pupil clearly stands out as a circle and the upper and lower eyelid areas above and below the pupil is also prominent. A Hough transform is then used to find the center of the pupil and its radius. Daugman is the first one to give an algorithm for iris recognition. His algorithm is based on Iris Codes. For the preprocessing step i.e., inner and outer boundaries of the iris are located. Integro-differential operators are then used to detect the centre and diameter of the iris, then the pupil is also detected using the differential operators, for conversion from Cartesian to polar transform, rectangular representation of the required area is made[6]. Feature extraction algorithm uses the modified complex valued 2-D Gabor filter. For matching, Hamming Distance has been calculated by the use of simple Boolean Exclusive – OR operator and for the perfect match give the hamming distance equal to zero is obtained. The algorithm gives the accuracy of more than 99.9%. Also the time required for iris identification is less than one second.

II. LOCALIZATION

For the preprocessing step i.e., inner and outer boundaries of the iris are located [8]. Integro-differential operators are then used to detect the centre and diameter of the iris, then the pupil is also detected using the differential operators, for conversion from Cartesian to polar transform, rectangular representation of the required area is made. For the specific case of the iris, Daugman uses the integrate differential operator given in Eq. (1). The advantage of such technique is that the same estimative can calculate the parameters for the iris and the pupil separately. It consists in:

$$\max(r, x_0, y_0)\left|G_\sigma * \frac{\partial}{\partial r}\int \frac{I(x,y)}{2\pi r}\,ds\right|$$

Where I (*x, y*) is an image containing an eye. The IDO Searches over the image domain (*x, y*) for the maximum in the blurred partial derivative with respect to increasing radius *r*, of the normalized contour integral of *I*(*x, y*) along a circular arc *ds* of radius *r* and center coordinates (*x*0*, y*0). The symbol $*$ denotes convolution and $G\sigma(r)$ is a smoothing function such as a Gaussian of scale σ.

III. SEGMENTATION

Segmentation refers to the process of partitioning a digital image into multiple regions (sets of pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. 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. In this process, we applied canny edge detector. By using this detector, we can easily see the gradient value. If global threshold value is used on that gradient image, the gradient values along the potential edge will be lost. In order to avoid that effect we can use local threshold in the area of interest [9] .The goal of texture segmentation is to partition an image into homogeneous regions and identify the boundaries which separate regions of different textures. Segmentation is obtained either by considering a gradient in the texture feature space or by unsupervised clustering or by texture classification. However, estimating the number of regions is a difficult problem and the results are usually not reliable.

A. CANNY EDGE DETECTION

The Canny Edge Detector is one of the most commonly used image processing tools, detecting edges in a very robust manner. The Canny edge detection algorithm is known to many as the optimal edge detector. Canny's intentions were to enhance the many edge detectors already out at the time he started his work. He was very successful in achieving his goal and his ideas and methods can be found in his paper, "A Computational Approach to Edge Detection" [10] . In his paper, he followed a list of criteria to improve current methods of edge detection. The first and most obvious is low error rate. It is important that edges occurring in images should not be missed and that there be no responses to non-edges. The second criterion is that the edge points be well localized. In other words, the distance between the edge pixels as found by the detector and the actual edge is to be at a minimum. A third criterion is to have only one response to a single edge.

The algorithm runs in 5 separate steps:
1. Smoothing: Blurring of the image to remove noise.
2. Finding gradients: The edges should be marked where the gradients of the image has large magnitudes. Compute the derivatives (Dx(x, y) and Dy(x, y)) of the image in the x and y directions i.e., use central differencing using the following 3 × 3 kernels:
Then compute the gradient magnitude and the angle of magnitude:

$$D = \sqrt{D_x^2(x,y) + D_y^2(x,y)} \qquad \theta = \arctan\left(\frac{D_x(x,y)}{D_y(x,y)}\right)$$

3. Non-maximum suppression: Only local maxima should be marked as edges. The "non-maximal surpression" step keeps only those pixels on an edge with the highest gradient magnitude. These maximal magnitudes should occur right at the edge boundary, and the gradient magnitude should fall off with distance from the edge.
So, three pixels in a 3 × 3 around pixel (x, y) are examined:
• If □′(x, y) = 0◦, then the pixels (x + 1, y), (x, y), and (x − 1, y) are examined.
• If □′(x, y) = 90◦, then the pixels (x, y + 1), (x, y), and (x, y − 1) are examined.
• If □′(x, y) = 45◦, then the pixels (x + 1, y + 1), (x, y), and (x − 1, y − 1) are examined.
• If □′(x, y) = 135◦, then the pixels (x + 1, y − 1), (x, y), and (x − 1, y + 1) are examined.
Pixel (x, y) has the highest gradient magnitude of the three pixels examined; it is kept as an edge. If one of the other two pixels has a higher gradient magnitude, then pixel (x, y) is not on the "center" of the edge and should not be classified as an edge pixel.
4. Double thresholding: Potential edges are determined by thresholding.
5. Edge tracking by hysteresis: Final edges are determined by suppressing all edges that are not connected to a very certain (strong) edge. As edge detection is a fundamental step in computer vision, it is necessary to point out the true edges to get the best results from the matching process. That is why it is important to choose edge detectors that fit best to the application. The Canny operator is optimum even for noisy images as the method bridge the gap between strong and weak edges of the image by connecting the weak edges in the output only if they are connected to strong edges. Hence the edges are more likely to be the actual ones. Therefore compared to other edge detection method, this Canny operator is less fooled by spurious noise.

B.HOUGH TRANSFORM

The HOUGH Transform is considered as a very powerful tool in edge linking for line extraction [11]. Its main advantages are its Insensitivity to noise and its capability to extract lines even in areas with pixel absence (pixel gaps). The Standard HOUGH Transform (SHT) proposed by Duda and Hart (Duda and Hart, 1972) is widely applied for line extraction in natural scenes, while some of its modifications have been adjusted for geologic lineament extraction purposes. The circle is simpler to represent in parameter space, compared to the line, since the parameter of the circle can be directly transfer to the parameter space. The equation of the circle is:

$(x-a)^2 + (y-b)^2=r^2$

As it can be seen the circle to get three parameter r, a & b, where a & b are the centre of the circle in the direction x & y respectively and r is the radius .Then we have a n dimensional parameter space (three dimensional space for a circle).
This model has three parameters: two parameters for the centre of the circle and one parameter for the radius of the circle. For ellipses and other parametric objects the algorithm is quite similar, but the computation complexity (dimension of the Hough space) increases with the number of the variables.

V.FEATURE EXTRACTION

The iris has an interesting structure and presents plentiful texture information. So, it is attractive to search representation methods which can capture local crucial information in an iris. The distinctive spatial characteristics of the human iris are manifest at a variety of scales [12]. For example, distinguishing structures range from the overall shape of the iris to the distribution of tiny crypts and detailed texture. To capture this range of spatial detail, it is advantageous to make use of a multi scale representation. Some works have used multi resolution techniques for iris feature extraction [13] and have proven high recognition accuracy. At the same time, however, it has been observed that each multi resolution technique has its specification and situation in which it is suitable; for example, a Gabor filter bank has been shown to be most known multi resolution method used for iris feature extraction and Daugman in his proposed iris recognition system demonstrated the highest accuracy by using Gabor filters. However, from the point of view of texture analysis one can observe that Gabor filter based methods analyzer pretty well the texture orientations. In this paper, we have investigated the use of wavelet maxima components as a multi resolution technique alternative for iris feature extraction. In this context, we have analyzed iris textures in both horizontal and vertical directions especially that the iris has a rich structure with a very complex textures so that it makes sense to analyze the iris texture by combining all information extracted from iris region by Considering all orientations in terms of horizontal and vertical details.

Iris Code Matching

The two iris code templates are compared by computing the hamming distance between them using equation [14].

$$HD=\frac{1}{N}\sum_{j=1}^{N} X_j (XOR) Y_j$$

Where, X_j and Y_j are the two iris codes, and N is the number of bits in each template. The Hamming Distance is a fractional measure of the number of bits disagreeing between two binary patterns The Hamming distance approach is a matching metric employed by Daugman for comparing two bit patterns and it represents the number of bits that are different in the two patterns. Another matching metric that can be used to compare two templates is the weighted Euclidean distance which involves much computation and this metric is especially used when the two templates consist of integer values. Normalized correlation matching technique also involves significant amount of computation. And hence Hamming Distance matching classifier is chosen as it is more reasonable [15] compared with Weighted Euclidean Distance and Normalized correlation matching classifiers, as it is fast and simple.

Biometric error analysis

All biometric systems suffer from two types of error: Type-1 is a false acceptance and Type-2 is a false rejection. Type-1 happens when biometric system authenticates an imposter. Type-2 means that the system has rejected a valid user. A biometric system's accuracy is determined by combining the rates of false acceptance and rejection.

A system that is highly calibrated to reduce the false acceptances may also increase the false rejection, resulting in more help desk calls and administrator intervention. Each error presents a unique administrative challenge. Therefore, administrators must

Clearly understand the value of the information or system to be protected, and then find balance between acceptances and rejection rates appropriates to that value. A poorly created enrollment template can compound false acceptance and rejection. For example, if a user enrolls in the system with dirt on his finger, it may create an inaccurate template that does not match a clean print. Natural changes in a user's physical traits may also lead to errors. The point of intersection is called the crossover accuracy of the system. As the value of the crossover accuracy becomes higher, the inherent accuracy of the biometric increases. Table (1) shows crossover accuracy of the different biometrics technology.

Biometrics	Crossover Accuracy
Retinal Scan	1:10,000,000+
Iris scan	1:131,000
Fingerprints	1:500
Hand Geometry	1:500
SignatureDynamics	1:50
Voice Dynamics	1:50

Table 1: Comparison of different biometric technology.

VI. CONCLUSION

We describe in this paper efficient techniques for iris recognition system with high performance. The iris recognition system is tested using CASIA image database. The segmentation is the crucial stage in iris recognition. We have used the global threshold value for segmentation. In the above algorithm we have not considered the eyelid and eyelashes artifacts, which degrade the performance of iris recognition system. We have presented a novel method for iris recognition which utilizes both the intensity gradient and texture difference between the iris and sclera or between the pupil and iris. The iris localization rate based on this method is much higher because the popular Hough transforms technique and the classical integro-differential operator in that methods only use the gradient information and hence cannot work well when the gradient is not strong enough.

The system gives adequate performance also the results are satisfactory. Further development of this method is under way and the results will be reported in the near future. Judging by the clear distinctiveness of the iris patterns we can expect iris recognition system to become the leading technology in identity verification.

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