Comparative Survey of Iris Recognition Using Hough Transform Method

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Abstract – Automatic recognition of a person depends upon the physical or behavioral characteristics of an individual. Out of all characteristics like fingerprint, voice, face, keystrokes, the most popular method of identifying an individual is based on iris recognition. The most difficult step in iris recognition is the segmentation because it enhances and affects accuracy of matching the iris from database. Hough transform method is popular method for detection of circular features. As the iris and pupil are circular in shape, hough transform is used to locate the center of iris in image. The first step is acquisition of iris image, after that segmentation is done, feature extraction is done and finally iris image extracted is compared form database. In this paper, circular hough transform method was discussed and then comparative survey has been done on hough transform which is used by various researchers to localize iris image.

Keywords: - Iris Recognition, Iris Segmentation, Circular Hough Transform, Feature Extraction, Matching.

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1. INTRODUCTION

Recognition and identification of an individual is required in every area like banking, airports, government and public sector. These authentications are based on person physical and behavioral characteristics. The physical characteristics include face, fingerprint, iris and behavioral characteristics include voice, keystrokes etc. Iris recognition is more popular in all traits because of large sample size, very simple and robust compared to other biometric traits. Segmentation is one of the most crucial step in iris recognition system as it localize iris inner and outer boundaries (Figure 1). The image can be captured in constrained environment where full cooperation of subject is required. But the most difficult step is when the iris image is captured in less constrained environment [2] due to reflection caused by light source, subject moving, rotation of camera and non uniform illumination caused by position and angle of light source. Iris is considered as a donut including colored ring of tissue around the pupil and has a very rich pattern of furrows, ridges, crypts, corona, freckles and pigment spots. These minute details of iris texture are believed to be determined during initial eye development. They are different for different persons and even for the two eyes of same person. Iris is found to be a well-protected and age invariant biometric.

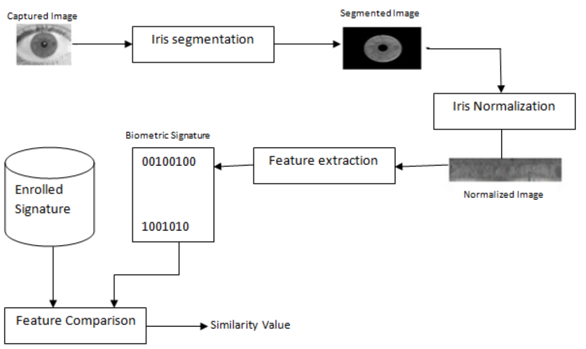

Figure 1 Iris Recognition steps

Almost all methods stated are based on the assumptions that centre of iris (Outer Boundary) and Pupil (Inner boundary) is same and iris is perfectly circular in shapes, which are practically incorrect. Therefore, the iris segmentation and localization from an acquired image leads to the loss of texture data near to pupil and/or outer iris boundary.

2. HOUGH TRANSFORM:

The hough transform is an algorithm presented by Paul Hough in 1962 for the detection of features of a particular shape like lines or circles in digitized images. The classic Hough Transform is a standard algorithm for line and circle detection. It can be applied to many computer vision problems as most images contain feature boundaries which can be described by regular curves. The main advantage of the Hough transform technique is that it is tolerant to gaps in feature boundary descriptions and is relatively unaffected by image noise, unlike edge detectors.

In an image, a curve "in any form" can be defined by a set of points. There is generally a set of parameters that links these points by their spatial information, or coordinate information in the image space. So it means that the curve is parameterized and can be modeled by a mathematical equation that gives the relationship between the two sets (for example, the equation of a line, circle...). Thus, the general principle of the Hough transform is a projection of the N-dimensional image space (denoted by I and defined by its variable i = 1: N) to a parameter space with a dimension M (denoted by H and defined by its variable j = 1: M).

3. LITERATURE REVIEW

Ramkumar & Arumugam [12] localize the pupil using negative function and boundary of pupil is identified precisely using four neighbors method. Thresholding techniques are used to differentiate iris region without eyelids and eyelashes occlusion. Pupil portion is distinguished by thresholding operations and as a result pupil region is detected approximately. In the next phase, pupil boundary is localized for each pixel using four neighbors method. Then iris region is localized using contrast enhancement, special wedges. Limbic boundary is also localized. Normalization is the process of unwrapping the annular shaped iris region into fixed and uniform rectangular shape, so that the transformation form Cartesian co-ordinate to polar co-ordinate takes place. The proposed method is based on CASIA iris image.

Jaehan et al. [8] proposed a robust iris localization method that uses an active contour model and a circular hough transform. Once the region of interest having the pupil and iris of an eye is selected, suppression of noise is done by Gaussian blurring. Then the image is binarized, histograms are generated and the center of pupil is estimated based on histograms. Next, the noisy holes in segmentation result are removed by morphology based region filling. After that pupiliary boundary is computed by applying hough transform to canny edge detector. Segmentation by active contour model and the hough transform method makes this method robust to error and noises. In the localization, region of interest should include as much pupil and iris region while minimally having boundary skin region. This process reduces the computation burden of future image processing since the size of image gets smaller without degrading the performance of segmentation. Then effect of noise is removed by region filling where specular high lights generate white holes within the pupil. Also, the noise is suppressed by Gaussian blur before finding edges of image.

After localizing the pupil, pixels within inner circles are marked as background in order to find the outer circle known as limbic boundary. If this condition is not met, an extra round of Hough transform is applied. For the testing of algorithms, CASIA iris image database version 3 was used.

Megha and Ayush [4] uses circular hough transform that is variant of hough transform for detection of circular features. Modified circular hough transform works by fixating the time space complexity in terms of reducing the area of image to cover and hence significantly decreasing computational time without compromising the accuracy of method. This method was tested on sample of collected iris images. Each image is divided into different size grid of size 3*3, 5*5 and 7*7pixels. Region of interest is nothing but valid region of image where probability of finding the center is highest. Image is divided into varying size grid of size say P*P. The algorithm suggests that for every grid sized P, the ROI only takes region from starting point SP to ending point EP. Also, if applying CHT takes time complex of order O(N * M), then reducing the number of pixels to process to M/P × N/P reduces the time complexity of modified algorithm by order of O((M/P * N/P)). The motive behind using varying size grid is to determine the future that in spite of using different areas resulting into different number of pixels to process, the robustness is still maintained or not.

Noureddine et al. [3] uses a robust method for detecting iris features in frontal face images based on circular hough transform. It is based on detecting the circles surrounding the iris pattern form set of facial images in different color specs. In an image, a curve can be defined as set of points. There is generally a set of parameters that links these points by their spatial information, or coordinate information in the image space. So it means that the curve is parameterized and can be modeled by a mathematical equation that gives the relationship between the two sets (for example, the equation of a line, circle...). Before the Hough transform is applied to the image, there was an edge detection technique used for finding the edges in the input image. First, we convert the image into the gray scale. Then extract the essential information of contour present in the image. The next step is after creating an accumulator h with the same dimension of the image, we extract the contour of image with the Prewitt filter. In the final step, locate the position Xi and Yi of N maximum points of accumulator; N represents the number of radius to search.

Heinz Hofbauer et al. [5] uses CNN based iris segmentation that is superior to traditional iris segmentation techniques in terms of segmentation error metrics. It requires parameterization of iris, based on the generated segmentation, to obtain the normalized iris texture typically used for feature extraction. RefineNet exhibits good performance for semantic segmentation. It is used as multi path refinement network, which employs a cascaded architecture with four refinenet units, each of which directly connects to output of one residual net. RefineNet was chosen over CNN architectures because of higher segmentation performance i.e. higher F-measure for generated masks, compared to a mask produced by human annotation. To assess segmentation performance, the generation of binary iris masks, tested the CNN on all samples in each database.

Lu Wang et al. [14] uses hough transform method for fast iris localization. First, the algorithm builds gray histogram of iris images to analyze gray threshold of the iris boundary. Then takes the pupil boundary binarization, using corrosion and expansion or region growing to remove noise. Then iris location was conducted based on hough transform according to geometrical features and gray feature of human eye image. In the region growing operation, the selection of initial seeds is crucial step. Balanced and smoothening operation was carried on the iris image in order to reduce non uniform illumination effects on iris recognition, in which gray balance is histogram equalization and smoothning is to wipe off noise by Gaussian filtration.

Amit Bendale et al. [1] proposed improved circular hough transform to detect inner boundary of iris form given eye image. Search space of standard circular hough transform is reduced from three dimension to only one dimension, which is radius. Local gradient information is used to improve time and efficiency of hough transform. It also provides error categorization for wrong segmentation as well as study on parametric influence on error. Pupil of the eye can be assumed to be circular and hence is modeled as a dark circular region within the iris. An eye image *I* is scaled down and thresholded giving a binary image *It* to filter out pupil pixels. This reduces the search space for pupil boundary iris inner boundary) only to the dark pixels in the image. But several types of noise pixels like eyelashes, eyebrows, shadow or specular reflection on the pupil pose severe problems. Morphological flood-filling operator is applied to remove holes from *It*. Inner boundary localization of iris is used to guide the outer boundary localization. The contrast across outer iris boundary is less compared to the inner boundary. Edge detection faces edge-strength thresholding problems. To tackle this problem, the robust circular integro-differential operator is used in a modified manner. This operator sums up pixel intensities over candidate circles and detects maximum change in this sum for neighbour circles per unit perimeter thus indicating presence of circular boundary.

F. Jan et al. [7] proposed reliable iris localization algorithm. It includes localizing coarse iris location in the eye image using hough transform and image statistics; localizing pupilliary boundary using bi-valued adaptive threshold and 2-dimensional shape properties; localizing limbic boundary by reusing hough accumulator and image statistics and finally regularizing these boundaries using a technique based on fourier series and radial gradients.

Naveen Singh et al. [13] proposed a novel technique and used a fusion mechanism that combines both a Canny Edge detection and circular hough transform to detect iris boundaries in the eye's digital image. Haar wavelet was applied in order to extract the deterministic patterns in a person's iris in the form of feature vector. First of all, outer edge is determined by sampling the images by factor of 4. Then a circular summation was applied which consists of summing the intensities over all circles. The circle with biggest radius and higest summation corresponds to outer boundary. The center and radius of iris in original image was determined by rescaling obtained results. The pupil center is shifted by upto 15% from the center of iris and its radius is not greater than 0.8 neither lower than 0.1 of the radius of iris. After determining the limits of iris, the iris should be isolated and stored in a separate image. For this purpose, they begin by changing coordinate system by unwrapping the lower part of iris and mapping all the points within boundary of iris into their polar equivalent.

Vineet Kumar et al. [9] proposed iris localization approach for the non ideal images of iris. Iris localization was achieved by accurately identifying boundary of pupil and limbic. Edge map generation and circular hough transform technique were used for identifying the boundary of pupil. The edge map is produced on intersecting the two binary edge maps acquired using thresholding and sobel edge identification. For limbic boundary detection, adaptive CHT was proposed for circular arc identification on edge map. The adaptive CHT was found beneficial for those images of iris that is obstructed by eyelids, hairs, glasses and eyelashes. Various tests were conducted on CASIA-iris-thousand V4.0 and CASIA-iris-lamp V3.0.

Matveev [10] also localize iris using hough transform. Problem is set in a way to detect only iris center position without evaluating its size. Such formulation allows us to reduce the dimension of parametric space compared to commonly used approaches that detect center positions and radius simultaneously. Apart, omitting radius estimation gives an opportunity to use points of both pupil and iris circles in hough transform, increasing the stability of method especially for images with poor pupil contour quality.

Matsoso and Padmaja [11] proposed circular hough transform method with horizontal and vertical derivatives for edge mapping for iris recognition. Segmentation involves generating an edge map using the canny edge detection. Bias the derivative in horizontal direction for detecting eyelids. Bias the derivative in vertical direction for detecting the outer circular boundary of iris. Vertical and horizontal gradients were weighted equally for the inner iris/pupil boundary. Since the pupil is always within iris region, hough transform for detection of iris/sclera boundary was performed within iris region. This makes the circle detection process more efficient and accurate. For accurate separation point between intra class and inter class distribution, false reject rate and false accept rate was used.

Caroline Houston [6] performed iris segmentation by using canny edge detection and circular hough transform. To overcome the pupil-iris center offset as well as iris stretching due to pupil dilation, the segmented iris image is broken down into sub-bands using 3rd level wavelet decomposition. The edge information in the 3rd level bands are combined and thresholded to create iris code that can be used for matching. Edge image was found by using canny edge detector. The canny edge detector was used as it is capable of detecting both strong and weak edges.

4. CONCLUSION

The physical characteristics such as iris, face, hand, patterns of finger vein and voice are unique to the individual. This paper discusses a review of the different existing method in iris localization under constrained and less constrained environment using hough transform method. The non ideal images of iris and constrained environment badly influence the accuracy and performance of recognizing iris. From this literature survey, it is noticed that almost all of the researchers does not meet the accuracy in iris localization under less constrained environment and noisy images. From the performance evaluation of techniques used by various researchers, it is being noticed that hough transform method is being the major technique that is being used by various researchers.

5. REFERENCES

1. Benfdale, A., Nigam, A., Prakash, S., & Gupta, P. (2012). Iris segmentation using improved hough transform. Springer, pp. 408-415.

2. Bowyer, K. W. (2008). Image understanding for iris biometrics: A survey. Comput. Vis. image Underst. , 110 (2), pp. 281-307.

3. Cherabit, N., Chelali, F. Z., & Djeradi, A. (2012). Circular hough transform for iris localization. Science and technology, 2 (5), pp. 114-121.

4. Chhabra, M., & Goyal, A. (2018). Accurate and robust iris recognition using modified classical hough transform. Springer.

5. Hofbauer, H., Jalilian, E., & Uhl, A. (2019). Exploiting superior CNN-based iris segmentation for better recognition accuracy. Elsevier, pp. 17-23.

6. Houston, C. (n.d.). Iris segmentation and recognition using circular hough transform and wavelet features.

7. Jan, F., Usman, I., & Agha, S. (2013, August 7). Reliable iris localization using hough transform, histogram bisection and eccentricity. Elsevier, pp. 230-241.

8. Koh, J., Govindaraju, V., & Chaudhary, V. (n.d.). A robust iris localization method using an active contour model and hough transform. International Conference on pattern recognition.

9. Kumar, V., Asati, A., & Gupta, A. (2016). Accurate iris localization using edge map generation and adaptive circular hough transform for less constrained iris images. International journal of electrical and computer engineering, 6 (4), pp. 1637-1646.

10. Matveev, I. A. (2012). Iris center location using hough transform with two dimensional parameter space. Pattern recognition and image processing, 51 (6), pp. 785-791.

11. Monaheng, M. S., & Kuruba, P. (2013). Iris recognition using circular hough transform. International journal of innovative research in science, engineering and technology, 2 (8).

12. RamKumar, R. P., & Arumugam, S. (2012, July 26-28). A novel iris recognition algorithm. IEEE-20180.

13. Singh, N., Gandhi, D., & Singh, K. P. (2011). Iris recognition system using a canny edge detection and a circular hough transform . International journal of advances in engineering and technology , 1 (2), pp. 221-228.

14. Wang, L., Yang, G., & Yin, Y. (2010). Fast iris localization based on improved Hough transform. Springer

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