An alternative approach to iris recognition technology exploiting intensity parameters as well as dimensional characteristics of pupil and iris

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Abstract: In present day world when identity circumferences many social, personal, professional outlooks, the identification of identity is highly critical. In pursuit of the same if we consider biological identity of person as a resource to identify his identity, we are approaching towards a new arena of a metric system call biometric system which enables us for automatic identification of an individual based on a unique feature or characteristic biologically possessed by the individual. Iris recognition is one of the celebrated technologies which are frequently finding its way into human life. Iris recognition encloses segmentation, feature detection and feature encoding. This paper explores pupil segmentation as subpart of segmentation process which MATLAB software version 2010b as the novel method to improve feature extraction.

Keywords: Iris Recognition, coordinates, intensity, co-centric, feature segmentation, extraction and encoding.

I. INTRODUCTION

Iris recognition is an automated method of biometric identification that uses mathematical pattern-recognition techniques on images of the iris of an individual's eyes, whose complex random patterns are unique and can be seen from some distance [1,2]. The first phase of iris biometric systems is capturing the sample of the iris. Then iris samples are pre-processed and segmented to locate the iris. Once the iris is located, it is then normalized from polar coordinate to Cartesian. Next, a template representing a set of features from the iris is generated. The iris template can then be objectively compared with other templates in order to determine an individual's identity. This paper presents the novelty involved in first step for the segmentation pupil by determining coordinates of image.

II. IMPLEMENTATION

Our alternative approach implemented the algorithm in MATLAB® code, is based on two assumed premises:
1. The intensity of brightness of sclera is greater than iris, whose intensity if brightness is in turn greater than pupil.
2. Iris and pupil are concentric.

Fig. 1: Flowchart of implemented algorithm.
The captions taken by implementing the present work is given below as:

1. Load Iris Image

![Fig. 2: loaded sample image of iris](image)

**Input:** Color Image or Grey Scale

**Output:** Centre of Pupil

- 1. X-coordinates of centre
- 2. Y-coordinates of centre
- 3. Radius of Pupil
- 4. X-coordinates of radius of Pupil
- 5. Y-coordinates of radius of Pupil

![Fig. 3: Pupil detection module](image)

2. Convert color image or grey image to binary image.
3. Replaces all pixels in the input image with luminance greater than level with the value 1 (white) and replaces all other pixels with the value 0 (black). Specify level in the range \([0, 1]\). This range is relative to the signal levels possible for the image's class. Therefore, a level value of 0.5 is midway between black and white, regardless of class.
4. In our case, we have generalized the threshold limit to the half of the pixel intensity of grey scale image.
5. Create a morphological disk structuring element. A flat, disk-shaped structuring element.
6. Produce a binary image.
7. Selecting a predefined threshold and employing intensity criteria loop over the boundaries.
8. Set the relevant threshold according to the data base and put the recent output image into loop to trace the exterior boundaries of objects. Image must be a binary image where nonzero pixels belong to an object and 0 pixels constitute the background.
9. Mark objects above the threshold with a black circle.

![Fig. 4: Isolated portion of pupil from sample image](image)
10. Isolating the pupil from image, calculate the center and radius of pupil.
11. The outputs achieved are then used in next module.

Input:
1. Grey Scale Image of eye to be compressed 
2. Coordinates of center of pupil 
3. Coordinates of boundary of pupil

Output:
1. X-coordinates of outer boundary 
2. Y-coordinates of outer boundary 
3. Radius of outer boundary

Fig. 6: Iris detection module

12. Taking the outer most boundary coordinates into account obtained as output of pupil detection module, again put the image obtained in step 11 into loop by employing intensity criteria and the required coordinates of iris boundary having known the fact that in almost all cases bare exceptions the intensity of sclera is more than iris, whose intensity in turn is greater than pupil’s.
13. This boundary coordinates along with the center of pupil gives the radius of iris.
14. Thus iris boundary is drawn.
15. The outputs obtained in previous two modules are taken in account as input to the next level of module called eyelid detection module to obtain a noise free iris portion of the image.

Input:
1. Grey Scale Image of eye to be compressed

Fig. 7: Boundary drawn on iris from sample image

16. The eyelids are modeled as lines.
2. X-coordinates of center.
3. Radius of pupil
4. Y-coordinates of boundary of Iris

Eyelids Detection Module

Output:
1. Edited image of eye

Fig. 8: Eyelids detection module

17. After calculating the extreme points on each direction of the image and applying radon transform we convert every eyelid pixel into a zero intensity black pixel thus mitigating the possibility of noise in iris portion.
18. Now the segmentation reaches its culmination where we subtract the pupil circle from its exterior iris circle thus obtaining only iris portion.
19. At this stage we have a circular portion of a tube like structure of only iris portion from the original image which is devoid of noise due to step 18.

Fig. 9: Boundary drawn on pupil and iris from sample image

20. From here iris starts its journey for the process of normalization.

Input:
1. Iris portion which is to be normalized
2. Angular resolution
3. Radial resolution
4. (X,Y) coordinates of boundary coordinates of pupil and Iris
5. (X,Y) coordinates of boundary coordinates of sclera.
6. Matrix containing line segments.

Output:
1. Normalized Iris
2. Normalized Mask*
   *Mask is used so that only informative and noise free portion is matched.

Fig. 10: Normalization module

21. The center of the pupil was considered as the reference point, and radial vectors pass through the iris region. A number of data points are selected along each radial line and this is defined as the radial resolution.
22. The number of radial lines going around the iris region is defined as the angular resolution. Since the pupil can be non-concentric to the iris, a remapping formula is needed to rescale points depending on the angle around the circle.
23. A constant number of points are chosen along each radial line, so that a constant number of radial data points are taken, irrespective of how narrow or wide the radius is at a particular angle. The normalized pattern was created by backtracking to find the Cartesian coordinates of data points from the radial and angular position in the normalized pattern. From the iris region, normalization produces a 2D array with horizontal dimensions of angular resolution and vertical dimensions of radial resolution[3].

24. A normalized mask corresponding to normalized iris pattern is generated in such a way that relevant iris data is represented by zero and noise is represented by one in mask template.

![Normalized Iris and Mask](image)

Fig. 11: Normalized iris and mask of sample image.

25. In order to generate the unique pattern corresponding to unique feature characteristics of normalized iris image we need to encode the normalized iris image.

![Feature Encoding Module](image)

Fig. 12: Feature encoding module.

Input:
1. Normalized Iris image
2. Angular resolution
3. Radial resolution
4. Normalized Mask

Output:
1. Encoded template is generated
2. Encoded Mask is generated

26. First we create a 2D-Gabor filter.
27. Transform the normalized image into frequency domain.
28. Take Convolution of normalized Iris Image & 2D Gabor Filter[4,5].
29. The rows of the 2D normalized pattern are taken as the 1D signal; each row corresponds to a circular ring on the iris region. The angular direction is taken rather than the radial one, which corresponds to columns of the normalized pattern, since maximum independence occurs in the angular direction.
30. Transform the convoluted output back to spatial domain.
31. Demodulation & quantized of the phase information is performed.
32. The encoding process produces a bitwise template containing a number of bits of information, and a corresponding noise mask which corresponds to corrupt areas within the iris pattern, and marks bits in the template as corrupt.
33. Since the phase information will be meaningless at regions where the amplitude is zero, these regions are also marked in the noise mask.
34. The total number of bits in the template will be the angular resolution times the radial resolution, times 2, times the number of filters used.

![Encoded Template](image)

Fig. 13: Encoded template of sample image
35. Thus the generated template is stored in data base for implementation.
36. After culmination of three basic building blocks viz. segmentation, normalization, feature encoding the next building block which in itself is a complementary part of every biometric system, is matching.

Input:
1. Template generated by test image.
2. Template generated by image to be compared.
3. Encoded (20*480) mask of test image.
4. Encoded (20*480) mask of image to be compared.
5. Angular resolution

Output:
1. Hamming Distance
   * Hamming Distance less than threshold value will give desired output.

Fig. 14: Template matching module

37. Matching module’s first task is to convert the templates and masks into logical class so that hamming distance could be calculated.
38. For matching, the Hamming distance was chosen as a metric for recognition, since bit-wise comparisons were necessary. The Hamming distance algorithm employed also incorporates noise masking, so that only significant bits are used in calculating the Hamming distance between two iris templates [6,7].
39. Now when taking the Hamming distance, only those bits in the iris pattern that corresponds to ‘0’ bits in noise masks of both iris patterns will be used in the calculation. The Hamming distance will be calculated using only the bits generated from the true iris region.
40. Predefining an approximately reliable value we compare the templates with hamming distance calculated in above step.
41. If the Hamming distance thus obtained is less than threshold the “Match Found” results is shown else “No Match Found” is displayed.

III. CONCLUSION AND FUTURE WORK

The iris recognition technology is comprehensively studied and implemented taking different characteristic feature. Our work on locating the iris region with help of pupil region by taking two assumption that :

(i) The intensity of brightness of sclera is greater than iris, whose intensity if brightness is in turn greater than pupil.
(ii) Iris and pupil are concentric.

Worked in fair manner in terms of segmentation, normalization, encoding as well as template matching module. Depending upon various dimensional features viz. distance of camera from iris, image quality of iris etc., the performance of our work varies in fairly good manner. We need not to extract iris region rather with help of above assumptions we have fairly segmented iris region with help of pupil dimensions.

IV. FUTURE RESEARCH

The future prospects of this work include calculating those images in which pupil pixels as well as eyelash pixels overlap.

REFERENCES

