Artificial Neural Network using Zernike Moments with Speeded Up Robust Features based Classification For Iris Recognition

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ABSTRACT

Objectives: The biometric models are being widely used for the purpose of authentication and human recognition. The biometric models are proposed to exploit the identity we have in the form of fingerprint, palmprint, IRIS, face matching, retina matching and other biometric features for the recognition of the humans. The biometric models necessitate the collection of the dataset of the persons, whose data must be obtained from the people being recognized under the complete biometric application. The IRIS recognition has emerged as the popular biometric model, and being used in the various types of the applications for online authentication, attendance systems, etc. The major problem associated with the IRIS features is that the IRIS region localization must be attained with the angular features along with the low level features in order to read the IRIS samples with higher accuracy.This paper aims at providing a hybrid model to provide precise iris recognition using Zernike moments, SURF feature detector and artificial neural networks.In this paper, a hybrid model has been proposed based upon the angular rotational shift with low level features for the insight of the robust IRIS recognition model. The incorporation of the Zernike moments has been completed in this model for the purpose of angular feature description, and to read the movement between the different samples of IRIS. The speeded up robust features (SURF) algorithm has been used to compute the low level features based upon the difference of hessian. The neural network classification has been proposed for the real-time IRIS recognition. The estimation of the proposed model has been done on the basis of various performance parameters such as recognition rate and overall accuracy. The hybrid proposed model has been found efficient and has been recorded with the higher order results in comparison with the existing model, when tested over the rotated sample database.

KEYWORDS: Low level features, SURF, Artificial neural network, biometric model,Zernike moments.

INTRODUCTION

Reliable and automate recognition of an individual has been under study for quite some time. Biometrics refers to the measurement of human characteristics. It is helpful to recognize the identity of individuals. In biometrics, physiological and behavioral characteristics of individuals are measured.

Physiological characteristics consist of fingerprints, face recognition, IRIS recognition, retina etc. whereas behavioral characteristics are concerned with the behavior of an individual for example, gait, voice etc. Biometric characteristics being unique to individuals are more reliable than token or knowledge based more efficient and almost fully automated systems with the advent of computers.

Iris recognition has advanced to become one of the most promising and reliable means of biometric authentication, though there are other means of biometrics which have been there for years, these features tend to vary with age and time. For instance a person who does a lot of physical work such as labor, the fingerprints might change or due to accidents the hand geometry also might vary and with age the facial features may vary. Iris recognition is the process of identifying individuals based on unique patterns within the circular-shaped region surrounding the pupil of the eye. The iris generally has a brown, blue, gray, or green color, with complex patterns that are visible when inspected closely. The color of the iris depends on the density of the melanin pigment in the eye and its absence results in blue colored iris.As an internal organ the iris is completely secured by the eyelids and the eyelashes as a result the iris is more stable and a reliable means of identification.

The various stages of iris recognition include taking the input image, detecting the iris from the image, extracting features to enhance the robustness and finally matching the extracted image with that in the database to recognize the correct iris of the intended individual. The input image sample first needs to be acquired correctly and for that at least a minimum of 70 pixels in the iris region should be resolved by the imaging system, the camera specifications are required to be chosen accordingly. For iris detection the segmentation of iris is required to be done for which an efficient segmentation algorithm should be chosen. The segmentation methodology adopted uses the retinex algorithm to improve the contrast and the rubber sheet model for normalization of the image[1].

The processing of local features is done in three steps, feature detection, description and matching. The local features generally are related to local key points[2].Various keypoint detectors such as Zernike moments, SIFT,SURF,FREAK can be used. Zernike moments are orthogonal descriptors which are uncorrelated hence they provide much more information.

A high rate of accuracy has been achieved for iris recognition with the state-of-the art technology for the images captured using NIR imaging[3]. However, research in the filed of visible imaging emphasizes on the need to develop robust feature extraction and matching methods for example, NICE.II competition [4].The popularity of iris recognition has made it a part of huge projects like the adhaar [5]project for identification of millions of individuals, cross-border migration control in UAE[6].In the quest to meet the increasing demand for higher security and forensic applications the major achievement is that of breaking the barrier of practical limitations i.e. to allow iris recognition from a particular distance and under less restrictive conditions. A number of iris databases consisting of iris images under less controlled conditions have been published for the public for further research. Among these UBIRIS, UBIRISv2 are the databases that have used visible illumination for acquiring the images[7,8]. The applicability of approaches based on NIR illumination reduces in case of forensic and security applications as they require a high degree of cooperation from the subjects.

MOTIVATION AND OUR WORK

Massive advancements have already been done in the sphere of iris recognition however, recognition of iris from a distance and under less restricted conditions still happens to be a challenge in case of visible imaging. The challenges posed are due to variation in light, blurred images, noise from multiple sources, eyelashes and much more. The present state of the art algorithms provide a number of solutions for images in the NIR region however a lot needs to be done for the visible imaging when dealing with less constrained environments. There is a need of more robust algorithms that can operate efficiently in visible as well as NIR illumination. However the Zernike moments phase features have been implemented and also in combination with bits stabilization and it was proposed to use Zernike moments phase features for efficient and accurate results under geometric and photometric transformations. The Zernike moments are orthogonal thereby giving more information and its phase features are rotation invariant which makes it more robust and stable.

The iris recognition strategy adopted in this work makes use of Zernike moments phase features for the purpose of angular feature description, and to read the movement between the different samples of IRIS along with speeded up robust features (SURF) algorithm to compute the low level features based upon the difference of hessian. The neural network classification has been proposed for the real-time IRIS recognition. Detailed information of the iris can be obtained by the simultaneous application of Zernike moments and SURF, which is then used to train the system using artificial neural networks.

The proposed method is evaluated on UBIRIS v1 and v2, which is a publically available database. UBIRIS v1 has noisy images and UBIRIS v2 has images that are taken in less constrained environments and took into account visible wavelength imaging.

Contributing towards the enhancement in the field of recognition of iris under less restricted environments, work was done on the realization of precise iris recognition at a distance making use of stabilized Iris Encoding and Zernike Moments Phase Features. This nonlinear methodology at the same time accounts for both consistency of locally present iris bits and also the overall quality of the weight map. This method more effectively amerce’s the fragile bits and on the other hand it rewards the bits that are more consistent. Zernike moments with phase based encoding has been applied for more efficient characterization of local iris features. The partially overlapping regions of the iris are used to calculate the zernike phase features to effectively adapt local pixel region variations in the normalized iris images. The authors adopted the strategy of simultaneously extracting and combining both the global and local iris features[1].

These days as the people are using contact lenses ,the technique of BISF for accurately detecting the textured contact lenses while performing iris recognition was used. The paper took into account three issues that are generally encountered at the time of creation of an algorithm for detecting contact lenses in iris images. One of the concern was if the segmentation of the iris region has to be accurate for achieving the unambiguous detection of textured contact lenses, however the outcome indicates that precise iris segmentation is not necessary. The other concern is that for algorithms trained on the images acquired from one sensor will apply to the images acquired from a different sensor. The third concern is related to the brand of contact lenses[9]. The collectively study of the various feature extraction techniques in iris recognition systems was performed[10]. Iris recognition is one of the most precise system for identity verification. J. Daughman initially introduced iris recognition and over the years many methodologies have been proposed to improve its performance. Various feature extraction methods have been introduced by many researcher sand an overview of the latest feature extraction methods for iris recognition have been discussed They have also presented the recent advancements in terms of precision, relaxibility and complexity giving an explanation of various methods to solve problems faced during the feature extraction stage of iris recognition.

An Iris recognition method under imaging conditions that are not ideal was developed[11]. The authors studied the issues faced during iris recognition in iris images that are degraded as they are not captured under ideal conditions for imaging. In these situations iris recognition poses a greater challenge because of noise factors such as off-axis imaging, pose variation, illumination change, blurring of images, occlusion, etc.They proposed a robust algorithm that makes use of Random Sample Consensus (RANSAC) for localizing iris boundaries that are not circular. With the help of RANSAC the iris boundaries can be localized more aptly than the methods that use hough transform.The image registration method based on LucasCKanade has been used to get information regarding deformation of the iris pattern. This method operates on the filtered iris images, it partitions an image into smaller sub-images and resolves the issue of registration for every small sub-image. Under some suitable assumptions this method becomes very effective. The authors also investigated as to how can highly distinctive features be obtained from deteriorated iris images.An amalgamated approach for unconstrained iris recognition was also used. The amalgamation of a variety of recognition approaches was proposed and described its contribution towards making reliable non-cooperative iris recognition by remunerating for deteriorated images taken under visible wavelength and varying light conditions and acquired using constrained acquisition setups and protocols[12].

Artificial neural networks have been used to predict the drop in pressure for various inlet-outlets in a heat exchanger[13] and also for controlling real time traffic in urban cities[14].The artificial neural networks have also been used for attaining a higher accuracy rate for mobile position estimation in a gsm network[15].

EXPERIMENTAL DESIGN

The angular shift feature has been obtained using the Zernike moments algorithm. The Zernike moments algorithm is designed to compute the set of radial polynomials for the calculation of the detection and measurement of angular rotation, upward or downward shift and the length of shift, which gives the exact position of the IRIS sample within the image. The Zernike moments models have been specifically designed to work over the 2-D image matrix and defined with the following equation:

$$Rnm(P) = \Sigma_{\downarrow}(s=0)^{\uparrow}((n-|m|)/2) \, [c(n,m,s) \; [P^{\uparrow}n]]$$

(1)

Where the variance value is defined with the variable c and n denotes the degree of the polynomials and azimuth angle is defined with the variable m. The variance (c) is computed with the equation (2) in the following step:

$$C(n, m, s) = (-1)^s (n-s)! \Big/ s!\left(\frac{(n+|m|)}{2} - s\right)!\left(\frac{(n-|m|)}{2} - s\right)$$

(2)

Where m gives the azimuth angle and n defines the order. The various conditions have been tested in this equation which must be satisfied for the accurate testing of the IRIS samples. The conditions ruling the prominence acquired with [n-|m|] along with [|m|<=n] are being tested to satisfy the computation of radial polynomial and the final rotational factors are computed on the basis of the orthogonal parameters. The following equation clearly defines the working of the proposed model algorithmic flow:

Algorithm 1: Hybrid IRIS recognition algorithm

Input 1: Training Data

Input 2: Test Sample

Output: Matching Sample

1. Acquire the training matrix
2. Get the testing sample selected by the user
3. Acquire the testing image matrix
4. If the image matrix is 3-d
    a. Convert to 2-d (Grayscale)
5. Apply the threshold measures over the 2-d input image
6. Localize the IRIS region in the input image
7. Acquire the region of interest from the input image
8. Compute the SURF features over the input image matrix
9. Apply the Zernike moments algorithm over the input test sample
10. Compute the rotation angle and distance after the application of Zernike moments
11. Apply the artificial neural network classification
12. Return the matching feature
13. Find the matching image from the matching sample
14. Return the final matching image with the matching sample details

RESULT ANALYSIS

The proposed model has been tested with the various samples obtained from the different samples. The variation in the degree of rotation has been tested in this model in order to verify the results in the case of variance. The following table 1 defines the results obtained from the samples rotated over 0 degree and 30 degrees.

Person / Angles	1	2	3	4	5	6	7
30	8	10	10	10	9	10	10
0	10	10	10	10	9	10	9
-30	10	9	10	10	10	9	10
Overall Accuracy	28	29	30	30	28	29	29

Table 1. The low range angle based testing of the proposed model

The result evaluation has been further extended over the higher variation order based samples. The angle variation of 15, 45 and 60 has been tested in this model. The results have been obtained from the first seven subjects and total 10 samples of each subject have undergone the testing phase. The table 2 defines the results obtained from the proposed model testing with variety of angles.

Person / Angles	1	2	3	4	5	6	7
60	10	9	10	10	9	9	10
45	9	10	10	9	9	9	9
15	10	10	10	10	10	10	10
-15	10	10	10	10	10	10	10
-45	10	10	10	10	9	10	8
-60	9	10	9	10	10	8	9

Table 2: The higher order based testing of the proposed model

The above table defined the results obtained from the high degree variations, which varies from the -60 to +60 degree samples, with the variance value of 15 degrees with exception of 45 to 15 degrees straight. It means the image features rotated on the different angles -60, -45, -15, 15, 45 and 60 degrees have been tested under this model. The proposed model has been tested with the higher accuracy at nearly 95% or higher, which signifies the robust performance of the proposed model.

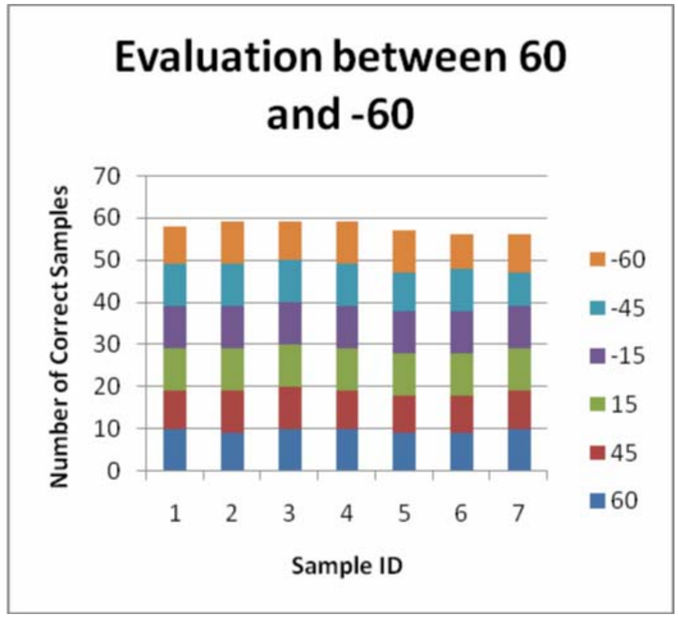

Figure 1: Result evaluation of non-zero angles (From -60 to 60) in the number of correct samples

The figure 1 shows the number of correctly detected samples over the different degrees. The differently colored chunks are clearly showing the results measured for the different angles of rotation, which are defined with the -60, -45, -15, 15, 45 and 60 degrees. The table 3 has been defined from the table 1 and 2 for the measurement of the overall accuracy. The proposed model has been detected with the high accuracy

Sample ID	**60**	**45**	**15**	**-15**	**-45**	**-60**	**Overall Accuracy**
1	10	9	10	10	10	9	96.67
2	9	10	10	10	10	10	98.33
3	10	10	10	10	10	9	98.33
4	10	9	10	10	10	10	98.33
5	9	9	10	10	9	10	95.00
6	9	9	10	10	10	8	93.33
7	10	9	10	10	8	9	93.33
Total	67/70	65/70	70/70	70/70	67/70	65/70	
Percentage	95.71	92.85	100	100	95.71	92.85	

ranging between 93.33% and 98.33%. The average accuracy of nearly 96% has been achieved in the analysis of the proposed model. The following table 3 shows the accuracy results in more detail:

Table 3: The overall accuracy based results computed over the table 4

The table 3 has signified the robust results obtained from the proposed model. The overall accuracy has been measured nearly at 96% and signifies the proposed model as the robust performer. The proposed model has performed significantly better in the terms of overall accuracy of recognition. The recognition rate of the proposed model is higher, when test over the variable degrees of samples ranging between -60 and +60. The following table 4 compares the performance of proposed model against the existing models:

S.No	Algorithm	Database (Rotated Samples Only)	Accuracy/Recognition Rate
1	Existing Model	UBIRIS v1 & v2	90.15%
2	Proposed Model	--Do--	96.31%

Table no. 4: Comparison of different algorithms

CONCLUSION

The proposed model has been defined by using the hybridized algorithm, which combines the Zernike moments, speeded up robust features along with artificial neural networks. The proposed model has been majorly defined to tackle the problem associated with the different angles of rotation. The proposed model has been defined to tackle the angular variation between the -60 and +60 degree samples of the IRIS shortlisted from the UBIIRISv1 and v2 samples. The recognition rate or overall accuracy remains the major parameter for the performance evaluation. The proposed model has been tested with more than 140 testing samples rotated over the different angles. The proposed model has been attained as the clear winner with the 96.31% accuracy over the existing accuracy of 90.15%, when tested over the set of testing samples under this performance evaluation model

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