Iris Identification enhancement based deep learning

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Abstract

Iris recognition is one of the most important biometric solution, which is used for individuals identification because of its unique features; so always there is need to improve and enhance recognition method used for that purpose, the proposed method aim to use un enhanced iris detection methods to ensure iris detection accuracy with acceptable speed , for large and different type of images from different source. the data is process using a set of preprocessing steps and normalized , then using deep learning technique which is known as UNINET, that work as feature extraction for the iris part .The net also have another sub net which is responsible for detecting the non-iris part that may affected in recognition result, so iris and non-iris part is depended during the matching stage. The proposed method gave promised result comparing with some of high benchmark methods, where the accuracy was 96.56, 99.26, and 99.8 for CASI, ITTD, and captured images correspondingly.

***Key word**: Biometric, Deep Learning, Fully Connected Network, Iris Identification, Uninet.*

Introduction

Individual identification and authentication are improved significantly by biometric systems, this play an important role in security for privet and public purpose (1)(2). Where biometric can be defined as "the automated use of biological properties to identify a person" (3). Biometric systems depend on physical and behavioral characteristic to identify persons, biometric systems are prefers to use as security solution due to its properties where its cannot be stolen, lost or forgotten (4). the most known biometric type that are used for authentication such as: finger print ,face, ,iris, signature , voice , palm print and others..(5)(6). for identification, iris Identification is the best because of stability of iris features for the individual through the live (7). Typically, each type of biometric have its advantages and disadvantages or challenges in use. Biometric system generally consist of: enrolment, preprocessing, matching and decision make, there are several algorithm and procedures for each stage, especially for the final stage, where it is very important to give the result (8). Neural network is used for this purpose, recently the use of deep learning is appeared as recognition and classification method, and it has given a very good result. The classic neural network styles problem is that they involve and need a many pre-processing and constraint tuning to give good results in certain data set, also there is no guarantee to have efficient solution on other biometrics or on a different dataset for e equivalent biometric. To overcome this problem, the researchers work hardly to find features. Deep neural networks have achieved good result on several datasets. In the deep learning framework, the images are input of the multi-layer neural network and the network learns the best way to find the features from the image to get accurate identification result (9).

In final years, the use of deep learning was in the advertisement of researchers because of the successful result they get by use it, so there are big number of research in this approach, which try to use deep learning neural network for iris identification systems in different way. Some of These work are shown in this paper, where Mohamed... et al., in 2016 (10). a system for iris classification by using feed forward neural network that trained by using two algorithm ,practical swarm optimization and gravitation search algorithm, their results emphasized that the use of the second algorithm is better than the first for training the neural network. Alaa S. Al-Waisy...et al.in 2017 [9] design iris recognition system using deep learning based on convolutional neural network and soft max classifier (multimodal),by using different database they tried to solve overfitting problem, the system gave good result with high speed but still to be improved. In 2017 also Shabab Bazrafkan, Peter Corcoran (11) they introduced a method that depend on using deep learning as segmentation tool for iris to the images take by handheld devises ,with the use of different database also with low quality images. In 2018 Rongrong Shi.. et al., (12) in this paper they tried to solve the problem of incomplete and not clear images that is used for iris recognition so they took part of iris by normalization operation then training these part using convolution neural network, it was good job but have problem of overfitting and need more preprocessing operations .in 2019 , Ming Liu.. et al, (13) aimed to increase the speed of convergence and accuracy by using fuzzy filter before the training of convolution neural network in order to improve the work of neural network for iris recognition, the result was good but they must try to use different member ship function to improve fuzzy filter. Also in 2019 Kien Nguyen…et al, (14) new design for neural network is proposed to have model with less computation and memory requirements that is used for iris recognition, they put constraints for the new model taking in account model size and computation.

The proposal design

The system aim to achieve high accuracy with compete speed, so there was some preprocessing stage for the image before it's entering to the fully convolution network.

The main steps for the proposed method where it has illustrated below and shown in fig. 1:

Figure (1): Main Steps of the proposed method

Preprocessing step

Preprocessing plays a very important role of identification or recognition process and it includes the following process:

First: Region detection

Two method are used to detect the iris region, one of them work to detect the region by window, and then the mission of pupil and iris detection is implemented inside the window. If this method is not success to find good result, automatically the second method is used, that deal with the whole eye image as work region with similar steps but without cropping, using of these two method make the work more accurate. There are many steps for this Process, as shown in fig. (2).

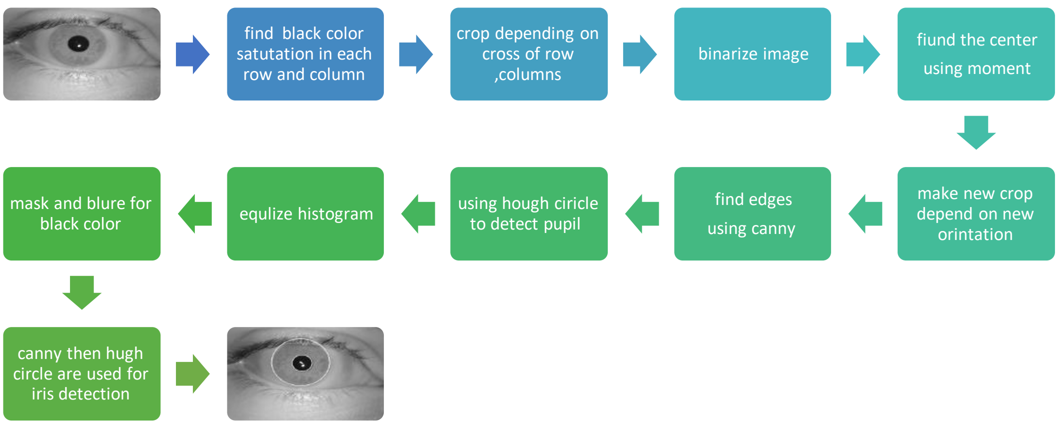

Figure (2) pupil and iris detection

These are implemented on different dataset type for eyes image and the results shown in fig. (3) (a) (b) (c).

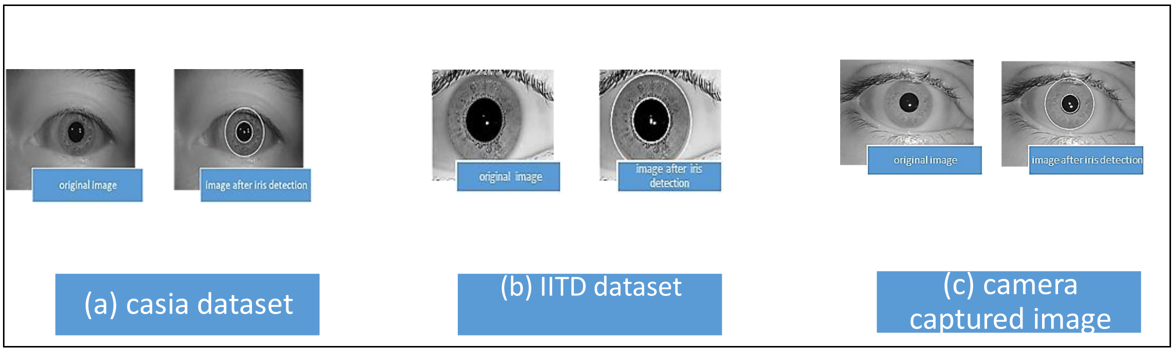

Figure (3) iris detection

Second: Normalization

After iris detection, Appling of normalization process to get static length feature vector that is used as input to learning phase.

Normalization is implemented by using "Daugman's" rubber sheet mapping that is worked as transformation tool for the original image format coordinate to polar coordinate.

Daugman's mapping receipts the point (x,y) that belong to the iris region to couple of polar coordinate(r, θ), r is lies between [0, 1] , θ is the interval [0, 2π] angle. The process represent arithmetically as follows:

$$I(x(r,\theta), y(r,\theta)) \rightarrow I(r,\theta) \quad \ldots 1$$
$$x(r,\theta) = (1-r)x_p(\theta) r x_l(\theta) \quad \ldots 2$$
$$y(r,\theta) = (1-r)y_p(\theta) r y_l(\theta) \quad \ldots 3$$

Here I(x, y) is the intensity value at (x, y) in the iris region image.

The constraints x_p, x_l, y_p, and y_l are the coordinates of the pupil and iris borders along the $\boldsymbol{\theta}$ direction. The result of Process is shown in fig. (4).

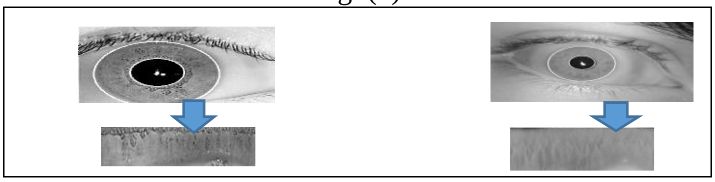

Figure (4) normalization process results

Feature extraction steps

Developed deep neural network structure, which known as (UniNet) is used this net depend on fully convolution neural network ,its used for feature extraction purpose ,as shown in fig. (5). The net contains of two fully convolutional network (FCN) dissimilar with typical convolutional net in that (FCN) have no fully connected layer. The main modules of FCN are convolutional layers, pooling layers, activation layers, etc. By combining up-sampling layers, FCN is able to achieve pixel-to-pixel estimate, so it is preferred to use for feature extraction. Feat Net is designed for extracting iris features, which are used in matching. There is also an important issue related with who to deal with noise in the normalized image, which represent the parts that is not iris like eyelash, and cause problem in matching ,net mask is designed for this purpose where it give a mask for non-iris part . Covering non-iris sections is necessary for loss function and for the matching process; .The result of this step is shown in fig. (6).

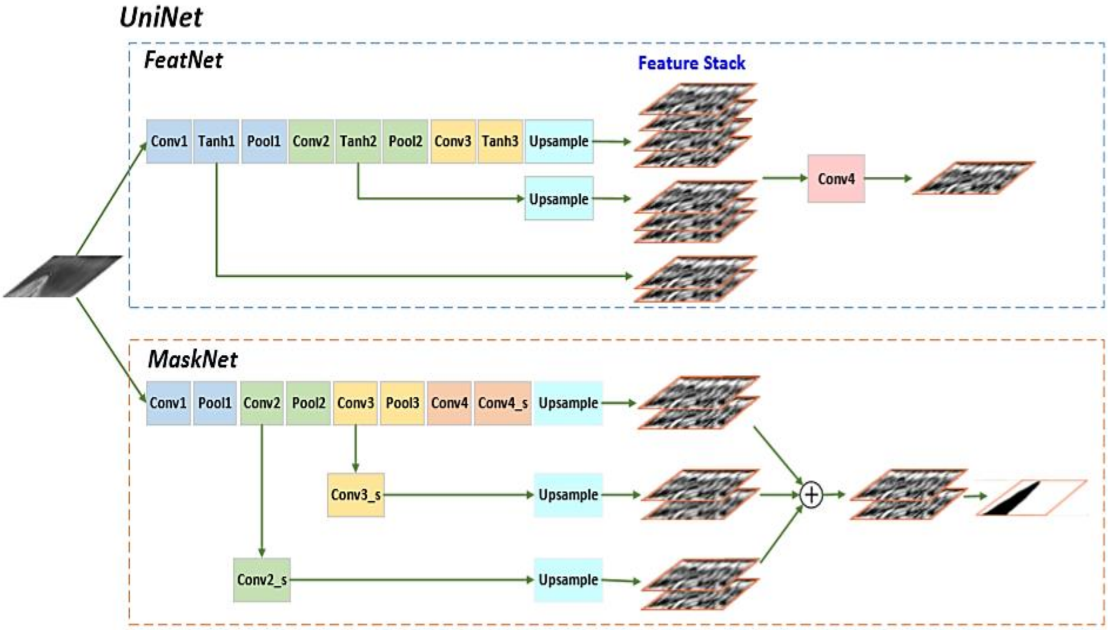

Figure (5) UniNet architecture (15)

For feat net learning, a triple network is executed. Where three alike Uninets, which have the same weight through training are located in the same time for forward and back propagate the data for positive, negative and anchor samples. Positive anchor represent iris image for the same individual, while negative anchor represent iris image for different individuals. The triplet loss function in general used for reducing positive anchor distance, at the same time increase negative anchor distance. However, in order to guarantee further suitable and actual control in the getting of iris features by the FCN, a bit-shifting operation is included to improved triplet loss function. The improved loss function is mentioned as Extended Triplet Loss (ETL).

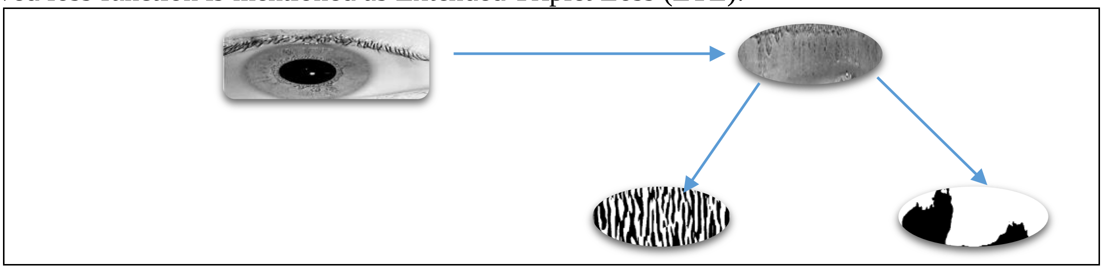

Figure (6) feature extraction results.

Extended Triplet Loss function

Mathematical representation for typical ETL is as describe below:

$$L = \frac{1}{N}\sum_{i=1}^{N}\left[\left\|f^{A}_{i} - f^{P}_{i}\right\|^{2} - \left\|f^{A}_{i} - f^{N}_{i}\right\|^{2} + \alpha\right]_{+} \quad ...4$$

N is the quantity of triplet models,$f^{A}i$, $f^{P}i$, and $f^{N}i$, are the feature maps of anchor, positive and negative images in the i-th triplet correspondingly. The symbol [•] + is corresponding to max (•, 0). (α) Is a specific constraint to control the preferred boundary between positive anchor distance and negative anchor distance. Improving typical loss function lead to decrease the anchor-positive distance and increase anchor-negative distance until their boundary is higher than a convinced value.

spatial features is used as dissimilarity metric, that consume the identical resolution with the contribution; the identical procedure has to contract through non-iris part masking and level by level shifting, which are normally detected in iris models. Therefore, the typical triplet loss function is extended, which is mentioned as the Extended Triplet Loss (ETL):

$$ETL = \frac{1}{N}\sum_{i=1}^{N}\left[D(f^{A}_{i}, f^{P}_{i}) - D(f^{A}_{i}, f^{N}_{i}) + \alpha\right]_{+} \quad ...5$$

Where D (f^1,f^2) characterizes the Lowest Shifted and Masked Distance function, represent as follows:

$$D(f^1, f^2) = \min_{-B \le b \le B} \{FD(f_b^1, f^2)\} \quad ...6$$

Set of mathematical operation including derivations is implement in a way to ensure that the feature map is more accurate ,feature map is produced after learning of the feature that include the accepted iris part and non-iris part.

Matching Process

First of all the features which is real value convert to binary to take less storage and also its known that the binary values is more resistance to brightness variation, blurring and other causal noise. The fractional Hamming distance is applied with the binarized feature maps and extended masks for matching. It is detected that the performance dose not reduce when binaries value is used matched with using the real-valued features, and this case profit minor improvements in some cross-dataset states.

Result analysis

The method training and test on different data sets and with the use of images captured by special camera. CASIA data set v4 for example, comprises 2,446 tasters from 142 subjects. Each tester have a part of the face, which contain both side eyes image together. Pictures are picked up at distance of three meters. All the right eye images from all the topics are used as training set, while all the left eye images is used as test set. The test set produces 20,705 genuine pairs and 2,969,534 fraud pairs. While, The IITD database holds 2,240 image samples from 224 subjects. All of the right eye images are used as training set while as check set, seven images for left eyes are used. The check set holds 2,240 genuine pairs and 623,400 fraud pairs.

Cross DB and Within DB configuration are used for test the work in order to increase the evaluation, cross DB mean that training is done with data set differs from the tested data set, The aim of the Cross DB situation is to scan the generality competence of the proposed structure under interesting situation that limited training tasters are existing. Within DB work to train net using one data set, then the independent training set from the objective database is used to adjust it. Then the adjusted network is estimated on the particular check set. The adjusted models from the Within DB structure are predictable to accomplish well than the model with Cross DB, depending on higher reliability of image quality between the training set and test set. It necessity be renowned that, training set and test set are completely disjointed, this mean that not any of the iris images are overlying between the training set and test set. Generally the tested results are produced under all-to-all matching protocol, its mean proposed feature extraction not only accomplishes higher accuracy but also exhibits unsettled generality capability. In addition, without other parameter tuning.

Results Comparison

The results of the proposed method are compared with some research's results that aim to iris identification, which have high benchmark. Comparison include OSIRIS(16), Gabor filter based Iris Code (17) with the result of proposed method for both cross and within database, the results of comparison are shown in table (1).

Tabl1 (1) results comparison

	CASIA		**IITD**		**Captured image**	
	FRR	**EER**	**FRR**	**EER**	**FRR**	**EER**
OSIRIS	**19.93%**	**6.39%**	1.61%	1.11%		
GABOR	**20.72%**	**7.71%**	**1.81%**	**1.38%**		
Ours CROSS DB	**13.22%**	**4.32%**	**0.80%**	**0.61%**	**0.50%**	**0.23%**
Ours WITHN DB	**11.9%**	**3.44%**	**1.16%**	**0.71%**	**0.92%**	**0.32%**

From the above table the rate results of the proposed method proof that this method is compete with other state of art method in iris recognition scope.

Conclusion

The use of the UNINET proof its successful in iris recognition purpose, due to using an enhanced iris detection methods and using two sub net for features extraction and mask for none iris part ,the determination and adding non iris part to the matching part make the result of matching more accurate. The other reason for getting these promising results is the good preprocessing techniques that applied to provide UNINET input, where the segmentation is done using two methods instead one to ensure getting exact iris part information. These techniques result in high accuracy, there is need to use more data set for training and testing. In addition, dataset with high resolution were needed.

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