

CAPSULE NETWORK BASED BIOMETRIC RECOGNITION SYSTEM

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Abstract: The biometric recognition plays a significant and a unique part in the applications that are based on the personal identification. This is because of the stability, irreplaceability and the uniqueness that is found in the biometric traits of the humans. Currently the deep learning techniques that are capable of strongly generalizing and automatically learning, with the enhanced accuracy is utilized for the biometric recognition to develop an efficient biometric system. But the poor noise removal abilities and the accuracy degradation caused due to the very small disturbances has made the conventional means of the deep learning that utilizes the convolutional neural network incompatible for the biometric recognition. So the capsule neural network replaces the CNN due to its high accuracy in the recognition and the classification, due to its learning capacities and the ability to be trained with the limited number of samples compared to the CNN (convolutional neural network). The frame work put forward in the paper utilizes the capsule network with the fuzzified image enhancement for the retina based biometric recognition as it is a highly secure and reliable basis of person identification as it is layered behind the eye and cannot be counterfeited. The method was tested with the dataset of face 95 database and the CASIA-Iris-Thousand, and was found to be 99% accurate with the error rate convergence of 0.3% to .5%

Keywords: Biometric Recognition, Retina Recognition, Capsule Neural Network, Deep Learning, Authentication.

1. INTRODUCTION

The latest development today have uses the conception of the sensor with the capability of the sensing the biometric traits of the humans to recognize their physical as well as their behaviors characteristics ensures an easy way of authentication, eluding the inconvenience in the traditional methods of the authentication using the identity card etc. [1] there are variety of biometric features such as the finger print, iris recognition, hand geometry recognition, facial recognition, facial expression recognition , gait recognition and so on , the biometric recognition plays a vital role in terms of the visual surveillance in the smart cities development.[2]

The identifications associated with the biometrics are unique and measurable attributes utilized in tracking an individual human beings. Some biometric systems are based on the single biometric information's and some are based on the multi-modal biometric information's, to make the authentication even more reliable and effective.

The recent advances in the deep learning has made them prevalent among the biometric recognition system .The convolutional neural network despites its deep learning capability in a wide range of applications, has found to be less efficient due to the because of the losses endured in the pooling layers by retaining just the noticeable features and removing all the over fitting that might be useful in the next layer. But the capsule network retains all the information's even the over fittings that are generate while pooling and utilizes the vector in representing the entity. So the capsule networks were found to more efficient than the traditional convolutional network [2]

Moreover the failures in the CNN to counterpart the flexibility and the accuracy of the human brain has made the capsule network that functions more like a human a predominant one. So the high accuracy and the learning capability of the Caps Net has made it highly prevalent than the convolutional neural networks.

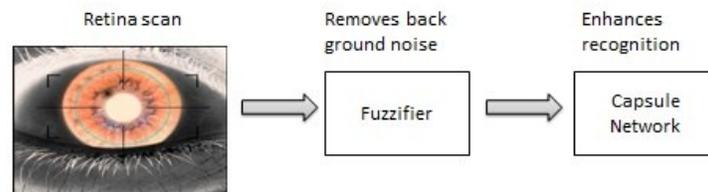


Fig.1 The proposed Flow Diagram

So the paper put forward capsule network based retina recognition along with the fuzzified image enhancement as shown in the fig.1 in order to avoid the slight back ground noises present in the images before subjecting to the capsule network.

The remaining of the paper is organized with the 2. The related works on the biometric recognition along with the deep learning methods, 3 the proposed retina recognition with the capsule neural networks and the fuzzy operations and the 4 providing the result and the discussion and 5. The conclusion.

2. RELATED WORKS

Phillips, et al [1] the author provides the bio-capsule authentication method for the facial recognition to improve the accuracy in the recognition and enable a unique way to secure and preserve the private information's. The proffered method utilizes the multi task convolution neural networks to conduct the facial as well as the facial landmark detection and was found to be outstanding compared to the prevailing biometric techniques.

Xu et al [2] the author propose capsule network based gait recognition in this paper, overcoming the disadvantages in the prevailing method, to provide a better way of surveillance in the public places such as the airport, railway stations, banks, schools etc.

Zhao et al [3] the author puts forward the essentiality of the “capsule network over the convolutional neural network and its uses in the iris based biometric recognition by using the state of art pre-trained models VGG16, InceptionV3 and ResNet50. The experiment is done on three iris datasets to determine the performance of the different network structures and tested along the strong and the weak light environments. In the same way the author Chui, et al [4] and the author Vinay et al [5] in his paper utilizes the capsule network in the facial recognition, to discover the procedure in the network and compare its capability to the brain. The former use the normal images of the face for the recognition based on the capsule network and the latter uses the infrared images for the facial recognition based on the capsule network.

Gunasekaran, et al [6] in order to make the verification process more and more stringent, the author proposes a “deep multimodal biometric recognition utilizing the contourlet derivative weighted rank fusion with the human face, finger print and the iris image.

Liu et al [7] the author necessitates the image enhancement required in the biometric traits before subjecting it to the deep learning techniques and utilizes the fuzzy operation to enhance the images, before subjecting into the deep learning methods such as the CNN and the Caps Net.

Lam et al [8] applies the convolutional neural network for the recognition of the finger print, Xiaosong, et al [9] proceeds with the research on the multimode biometric recognition utilizing the neural networks. Akhtar et al [10] the author present the over view of the recent technologies in the face manipulation, generation detection and the recognition data base. The author Tereikovska et al [11] , Gordienko et al [12] , Gumusbas, et al [13] , Peng et al [14], Luo, et al [15] present the utilization of the capsule network in the recognition of the face, graffiti handwriting, off-line signature , breast cancer related genes and the gaze estimation in the wireless sensor networks. The above papers present the biometric recognition based on the face, iris, hand writing, signature, finger print, etc., all these above biometric can be counterfeited or duplicated. So the paper put forward a biometric recognition based on the retina, utilizing the fuzzy operation and the capsule network to present a more reliable biometric system that is irreplaceable.

3. PROPOSED WORK

The biometric system based on the retinal scan detects an individual using the irreplaceable patterns of the human retina. The retina in the back side of the eye with the iris in the front part comprises of complicated blood vessels (veins of the retina) patterns via which the retinal scanner detects as well as distinguishes between the individuals. The utilization of the retinal scanners is mainly found in the government sectors and the intelligent assistances for the verification and the detection process. The eye scanners nowadays are becoming more and more popular even in the public sectors such as the banks, railway stations, automatic teller machines, hospitals etc. The retinal recognition is found to be highly reliable and robust as it is could not be duplicated like the finger print, iris, palm, gait and the face recognition. The biometric system based capsule network for the retinal recognition would be more effective way of verification than the other methods.

The Retinal recognition is shows 70% accuracy than the iris scans and the 99% accuracy compared to the finger print recognition, it is 100 times and 20,000 times better when comparing with the recognition that is based on iris and the finger print respectively.

The retina in the human eye is a thin type of tissue that is comprised of the neural cells that is layered in the latter (posterior) part of the eye. The retina for each person seems to be unique as the structure of the capillaries that supply blood to the retina is a complex. As the structure of the retina is not genetically decided, the pattern in the retina differs even in the identical twins. Doctors say that the retina pattern could change, when a person is affected by the glaucoma or retinal degenerative disorders or the diabetes, but the retina naturally remains unchanged from

the birth to the death. Due its uniqueness and the unchangeable nature, the retina recognition is a highly precise and a most reliable biometric apart from DNA.

So the biometric system based on the retina recognition needs a vascular pattern enhancement before the subjected to the capsule networks. The figure.2 below shows the retinal and the complex structure of the blood vessels that makes the retinal of the each person unique.

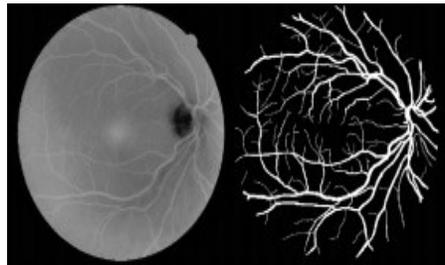


Fig .2 Retina with the complex structure of the blood vessels

So the proposed process of the capsule network based biometric recognition initiates with a preprocessing [3] to locate the region of interest, followed by the fuzzified image filter [7] to remove the back ground noises in the images, further uses the Gabor wavelet [16] for the vascular pattern extraction and finally subject the image into the capsule network for enhancing the recognition.

3.1. PROPOSED BIOMETRIC SYSTEM FOR RETINA RECOGNITION WITH THE CAPSNET

The flow diagram of the proposed biometric system for the retinal recognition utilizing the Caps Net is shown below in the fig.3.

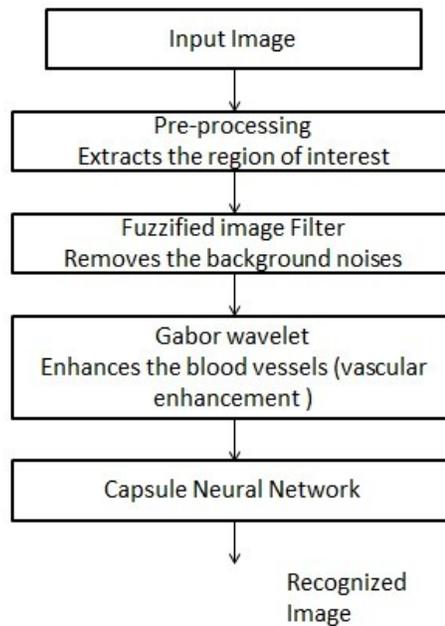
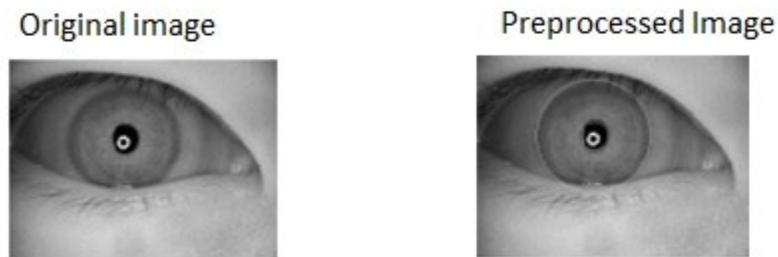


Fig. 3 Flow Diagram of the Proposed Biometric System

(a) Pre-processing [3]

The eye ball is initially located and segmented from the 640* 480 actual input images provided, and then the region of interest is extracted and normalized to 256*32 and further enhanced, later the normalized image is resized to the 197*197 using the nearest neighbor algorithm that is provided as the input. The fig .4 below shows preprocessed image of an eye.



(b) Image Enhancement by Applying Noise Removal [7]

The boundaries of the retina are identified and the region to be smoothed is separated from the region to be enhanced. The fuzzified image filters based on the average and the median is applied to the retina of the images to remove the back ground noise found in the images. The output obtained from the smoothening filters is given below in the equation (1)

$$X(m, n) = \frac{\sum_{(a,b) \in s} f(x(m+a, n+b))x(m+a, n+b)}{\sum_{(a,b) \in s} f(x(m+a, n+b))} \quad (1)$$

Where the 's' is the sliding window on index (m, n) and the (a, b) is the image pixel and the f(x) is the window function.

(c) Complex Blood Vessels Extraction [16]

The C that is very prominent due to its direct selective capability in identifying the oriented features and fine tuning is applied to retina images for extracting the blood vessels structure of the retina and enhancing them. The image is subjected to the Gabor wavelet transform. The selected scale value and the location of the each pixel is computed using the equation (2) shown below.

$$W_{\varphi} (a, b) = \max \theta [M\varphi (a, b, \theta)] \quad (2)$$

The enhanced vascular pattern is obtained for the retina images. The retina image with the enhanced vascular pattern is subjected to the capsule neural network for the recognition. The fig.5 below shows the enhanced vascular pattern of the retina obtained at the output of the Gabor wavelet transform.



Fig. 5 Enhanced Vascular Pattern

(d) Capsule Neural Network [2-5] [11-15]

The capsule network follows a dynamic routing mechanism to extract the features as well as the classification. Unlike convolutional neural network the capsule network utilizes the vector-output capsules as well as the max pooling enabled with the dynamic routing to retrieve the precise position information and the retina recognition. The capsule neural network applied previously in the recognition of the iris and the finger print is utilized for the retina recognition. The fig.6 below provides the capsule neural network in the retina recognition.

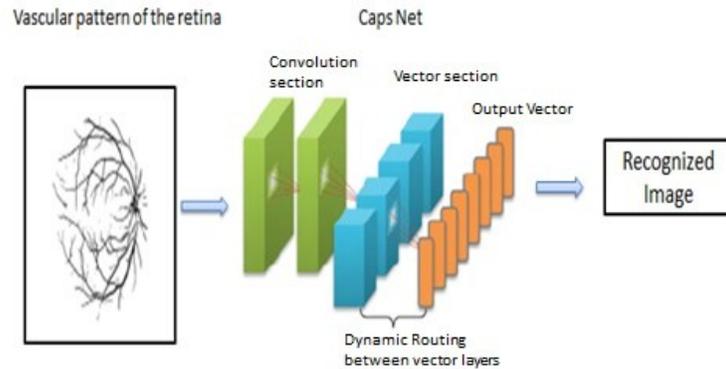
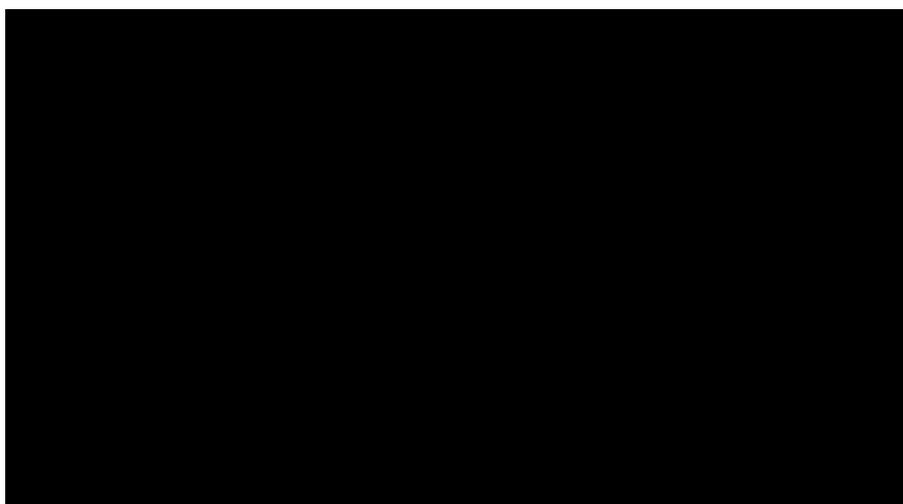


Fig.6 Retina Recognition based on Capsule Neural Network

4. RESULTS AND DISCUSSION

The proffered method is tested using the CASIA-Iris-Thousand datasets [3] that was provided from the Chinese academy of science for the biometrics and the security research and the face 95 databases [6] that comprised of total number of 1440 images. The experimental set up for the retina recognition utilized the AlexNet, ILSVRC2012 winner for training with the ReLU and L2 used in the normalization and reducing the over fitting respectively and the classification using the soft max. The table.1 below provides the accuracy achieved in the retina recognition through the capsule neural network and the CNN for different number of images.



The table .1 Comparison of the accuracy of the CNN and the Caps Net

Further the reliability and the robust ness of the retina recognition is compared with the other biometric recognition such as the finger print [8], gait [2] signature [13] and the iris [3] and was found that the retina recognition was irreplaceable and highly reliable compared to the biometric system based on the other recognition method mentioned above. So the paper provides an improved way of verification utilizing the retina recognition based on the capsule neural network.

5. CONCLUSION

The biometric recognition system that utilizes the capsule neural network for the retina recognition incorporates the fuzzy operations to enhance the images with the removal of the noise, and the Gabor wavelet transform to extract the vascular pattern of the retina before subjecting to the capsule network. The enhanced vascular pattern of the retina is fed into the capsule network that enables a perfect recognition leading to a proper verification compared to the CNN. As the biometric system is based on the retina recognition the duplication and the counterfeit could also be reduced enhancing the verification process. This proffered method could be utilized in airports and the other public sectors that require the ID proof of the individuals. Further the paper is to proceed with the implementation of the proffered method in the verification process involved in the public sector.

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