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Iris Feature Extraction for Personal Authentication Using Macro Features

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Abstract: Iris pattern analysis is the most popular technology used in biometric recognition. The main aim of this proposal is to perform the feature extraction of iris by analyzing the macro features such as crypts, radial furrows, lacunae, lesion, etc. Iris has special features which are unique and stable over the individual's lifetime. Because of this reason, iris pattern analysis has been increasingly used in data security. Iris image classification can be done with the help of Convolutional Neural Network (CNN) through which different patterns of the iris can be mapped. The vector part of the image is analyzed with the help of Capsule networking. The image classification and feature extraction can be done efficiently using CNN and capsule network with the help of Dynamic Routing with Direction and Length (DRDL) algorithm. DRDL is a modified routing algorithm which can be performed by dynamic routing between capsules. The experiments are conducted on PEC database. PEC database consist of about 434 images in which features of iris can be extracted. Formats of the images are in PNG files.

Keywords: Capsule Network, Convolutional Neural Network, Dynamic Routing with Direction and Length, Feature Extraction, Macro features.

1. INTRODUCTION

Medical records are the most sensitive data that have to be maintained securely. Many electronic devices can access these data and they can be modified. Thus security of the data is very important in healthcare to safeguard the information of the patients. Biometric system plays an important role in healthcare applications which helps to access the record securely and facilitates correct identification. In this concern, iris biometric system is one of the most popular, accurate and reliable system for identification of an individual as well as personal authentication[6].

Iris pattern analysis is the method of identifying an individual with regards to their iris pattern. Deep learning has significant effect on performing numerous computer vision tasks. Thus, deep learning approach, using Convolutional Neural Networks (CNNs) [3], is used to describe the features by analysing the pattern of iris. Due to the depth of CNN layers, there arises a problem. As information about the data enters into large number of layers, it might be lost as it reaches to the end of the network. To increase the flow of information in the network, all the layers are directly connected [5] with one another. To retain the feed-forward nature, current layers in the network obtain its input from the previous layers.

Researchers have shown that features of CNN are highly efficient for numerous tasks, such as classification, action and facial recognition and are not only meant for detecting objects and classification of images. Although CNN has good concern with feature classification, it can be easily affected by noise and the disturbances in the external environment. Further, some of the valuable spatial information about the data might be lost due to the process of pooling function.

Due to these difficulties, the network called capsule is introduced to overcome the limitations of using CNN for recognizing the features of iris [1]. Each layer in the network architecture is condensed into group of neurons called "capsules" and each node corresponds to an active capsule. The output of a capsule can be iterated with the help of dynamic routing mechanism [4] in which the output from one capsule is feed to an input of subsequent capsules.

Dynamic routing between capsules may lack in correct detection of the objects in accordance with the adjacent objects. Hence the proposed work uses CNN and capsule networking by using Dynamic Routing with Direction and Length (DRDL) algorithm.

2. LITERATURE SURVEY

In this survey, review about the various techniques for recognizing the features of iris and their methods have been discussed. Iris segmentation has got high attention, because of its performance and accuracy. Iris segmentation can be done by an improved Circular Hough transform and Radon transform. The standard Circular Hough transform (CHT) is done by estimating the shape of the radius inside the given image. The inner radius is detected before the outer radius, because the pupil is the darkest region that can be detected easily [6]. The papillary region is found properly by employing an updated Circular Hough transform to get the center and radius of the pupil.

Convolution Neural Networks (CNNs) is one of the deep learning methods that perform many tasks such as object recognition and detection. CNNs belong to the deep learning concept made for processing image and videos. By using the blocks of neurons like a convolution layer that is put in an order across images, CNNs [3] have outgrown many conventional hand-crafted feature techniques. Still it needs compression to reduce the network size and the computational complexity of CNNs in the training process is high.

Another approach used for making the network deeper is by increasing the network width. Here all networks are directly connected to each other. To improve the flow of information between layers, another connectivity pattern is introduced which involves direct link from any layer to all consequent layers. Because of its thick link, the network architecture is referred to as Dense Convolutional Network (DenseNet) [5]. DenseNets are considered as feature extractors for several computer vision activities that build on convolutional features, but such feature transfer with DenseNets is yet to be studied. The deep Convolutional Neural Network (CNN) is the popular method of processing an image, but anti-noise capacity in classifying the image is very less and it can be affected by minor instabilities. Hence the capsule network is introduced to overcome the bounds of using CNN. Capsule is known as a group of neurons which sends the output from lower level to higher level in the network. This is achieved using dynamic routing mechanism [4]. Dynamic routing mechanism lets the capsule at higher level to go to some active capsule at lower level. However the accuracy is less than dynamic routing with direction and length.

The detailed structure of the network is accustomed, and an improved routing algorithm considering the dynamic routing between capsules is given for analyzing the iris pattern. This method is called as Dynamic Routing with Direction and Length (DRDL) [1]. Dynamic routing algorithm, taking direction and length of vectors into account is known as DRDL algorithm. The direction and length of vectors are combined as the evaluation metrics. The networks employing the Dynamic Routing with Direction and Length (DRDL) algorithm get an improved result than dynamic routing algorithm. The network with capsule structure is steady in critical cases, yet there might be less accuracy. Table 1.1 specifies the comparative studies of various techniques for recognizing the features and their related work.

Table 1. Comparative studies of various techniques for recognizing the features and their related work

S.No	Author& Year Of Publication	Title	Methods Used	Dataset Used	Parameters Used	Results	Limitations
1	Zhao, Tianming, Yuanning Liu, Guang Huo, and Xiaodong Zhu 2019	A deep learning iris recognition method based on capsule network architecture	Dynamic Routing algorithm with Direction and Length [1]	CASIA-V4 Lamp dataset	Learning Rate (LR), Accuracy, Equal Error Rate (EER)	The accuracy of InceptionV3_6blocks+DRDL network reaches 92.34%, with a decrease of only 7.33%	The results shows that the accuracy of the networks with capsule architecture decreases by approximately 15%
2	F. Marra, G. Poggi, C. Sansone, and L. Verdoliva 2018	A deep learning approach for iris sensor model	CNN architecture and selective enhancemen	CASIA-IrisV2, CASIA-IrisV4	Receiver Operating Characteristics(ROC), True Acceptance	TAR performance at 10% FAR is 92.49% in the baseline cross	High complexity

		identification	t algorithm [2]		Rate(TAR), False Acceptance Rate(FAR)	sensor scenario, growing to 97.12% and to 98.09% in CNN	
3	K. Nguyen, C. Fookes, A. Ross, and S. Sridharan 2017	Iris recognition with Off the-Shelf CNN features	Network architecture used in CNN [3]	ND-CrossSensor-2013 and CASIA-Iris-Thousand	Recognition Accuracy	DenseNet achieves the highest peak recognition accuracy of 98.7% at layer 6 on the LG2200 dataset and 98.8% at layer 5	Needs compression to reduce the network size, high computational complexity
4	S. Sabour, N. Frosst, and G. E. Hinton 2017	Dynamic routing between capsules	Dynamic routing algorithm [4]	MNIST	Test Error Rate(TER), Accuracy	An under-trained CapsNet achieved 99.23% accuracy on the expanded MNIST test set	Accuracy is less than DRDL
5	Huang, Gao, Zhuang Liu, Laurens Van Der Maaten, and Kilian Q. Weinberger 2017	Densely connected convolutional networks	Composite function, pooling layers [5]	CIFAR-10, CIFAR-100, CVHN and ImageNet	Test Error Rate(TER), Accuracy	On C10, reduction in error about 29% from 7.33% to 5.19%. On C100, reduction in error about 30% from 28.20% to 19.64%	It consists of large number of layers
6	Alaa S. Al-Waisy, Rami Qahwaji, Stanley Ipson and Shumoos Al-Fahdawi 2015	A fast and accurate iris localization technique for heathcare security system	Modified Circular Hough transform and Radon transform [6]	CASIA Version 1.0 and SDUMLA-HMT iris database	Accuracy rate and average Runtime	Correctly localize the iris boundaries from 749 out of 756 eye images in the CASIA database, while 517 and 511 eye images are correctly segmented out of 530 in the SDUMLA-HMT database for the right and left eye	Cannot be efficient with large datasets and more noisy images

For extracting the features from iris, we need to classify the images and mapping should be done in efficient manner. The vector part of the image should be analyzed for correct prediction. For this, the existing work lack in the correct detection of the objects in accordance with the adjacent objects. The error rate may be high with the existing work and some of the spatial information might be lost. The proposed work can overcome these difficulties with the help of Convolutional neural network

and Capsule networking by using Dynamic Routing with Direction and Length (DRDL) algorithm [1].

- The proposed work can classify the layers with the help of Convolutional neural network (ConvNets or CNNs). CNN is one of the main categories to do image recognition and feature learning. CNN image feature learning takes an input image, process it and perform classification [3].
- The vector part of the image can be analyzed with the help of capsules. A capsule is defined as a group of neurons whose activity vector is represented as the instantiation parameters of a specific type of entity such as an object or an object part. The idea behind this is to add structures called capsules to a Convolutional Neural Network (CNN), and to reuse output from several of those capsules to form stable representations for higher order capsules [4]. Here, the classification of layers is done with the help of capsule networking. The outputs from one capsule are routed to capsules in the next layer, accordingly the patterns are predicted.
- The method follows the algorithm called Dynamic Routing with Direction and Length (DRDL), taking direction and length into consideration. By combining these methods the error rate can be reduced and the recognition of the features can be increased [1]. The most important idea is that similarity between input and output is measured as dot product between input and output of a capsule and then routing coefficient is updated correspondingly. Fig.1.1 describes the overall flow diagram of extracting features from iris.

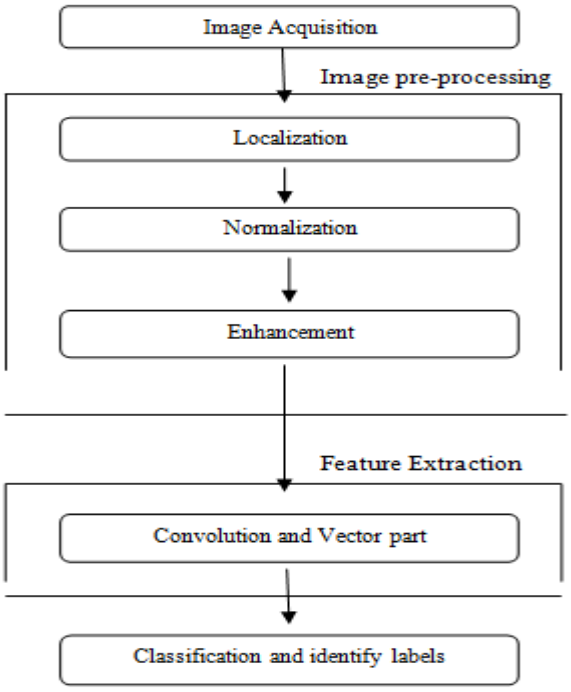

Figure 1.1 Overall flow diagram

The process of pre-processing involving localization, normalization and enhancement of an iris can be described in Fig.1.2.

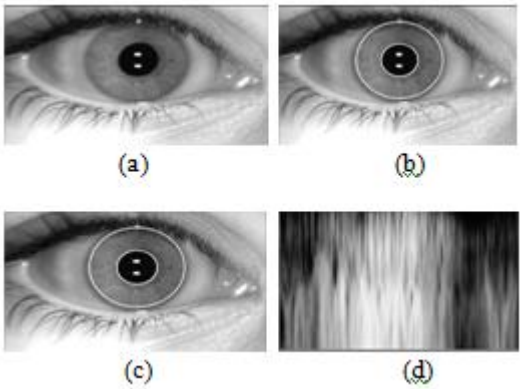

Figure 1.2 iris image pre-processing stages: (a) iris image, (b) iris localization, (c) iris normalization, (d) iris enhancement

3. CONCLUSION

In this survey, various techniques have been studied and their merits and demerits have been discussed. We propose a method of combining Convolution Neural Network for classifying the layers and Capsule network for analyzing the vector part of an image where the routing between capsules can be efficiently done with the help of dynamic routing between capsules with Direction and Length algorithm (DRDL) which is very useful in extracting the features of iris in medical applications. By combining these techniques the object can be efficiently recognized and features can be extracted appropriately from iris. Our future work aims at reducing the overall error rate and increasing the accuracy.

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