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# FINGER- VEIN BIOMETRIC IDENTIFICATION USING CONVOLUTION NEURAL NETWORKS

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**ABSTRACT**

In recent years, the need for security of personal data is becoming progressively important. Biometric Authentication Technology has been widely used in this information age. As one of the most important technology of authentication, finger vein recognition attracts our attention because of its high security, reliable accuracy and excellent performance.. Unlike existing biometric techniques such as fingerprint and face, vein patterns are inside the body, making them virtually impossible to replicate. This also makes finger-vein biometrics a more secure alternative without being susceptible to forgery, damage, or change with time. To solve this problem, a finger vein recognition method based on the convolution neural network (CNN) is proposed in this paper

**Keywords:** Finger vein, convolution neural network, biometric identification

## 1. INTRODUCTION

The need for security of personal belongings and information is becoming increasingly important [1]. The design of efficient biometric identification systems, measuring unique physical or behavioral characteristics of individuals for their secure recognition, is nowadays a challenging and relevant task for both the scientific and the industrial communities [2] [3]. Conventional biometric personal identification systems, which are based on physiological characteristics and behavioral patterns such as faces, irises, or fingerprints, have several drawbacks [4] [5]. The features can be forged due to physical appearance to the human eye. Hence, the features are susceptible to damage or change with time. An example of this type of biometric trait is a fingerprint [6]. Also Iris recognition is considered as less user-friendly since it can cause discomfort due to the brightness of the light during the biometric capture process [7].

Biometric recognition technology has a long development history. At present, there are so many categories of biometric technologies such as fingerprint, face, iris, speech and other features[41][42]. Although these biological features are unique, accessible, widespread and can be regarded as markers of human identity, some challenges still exist [8] .In recent years, it has been proved that the error rate (ERR) of finger vein recognition can reach 0.0009% under certain conditions[43][44].At the same time, finger vein identification also has the following advantages: (1) It is a non-contact biometric identification method without finger touch, so it is easy to be accepted by the user. (2) Finger vein belongs to human's internal characteristics, and it cannot be copied and embezzled. (3) It has been proved by medical science that finger vein is unique. (4) Each of us has ten fingers. If there is a sudden condition, we can use other fingers instead[45].

## 2. RELATED WORK

A biometric system is essentially a pattern recognition system which makes a personal identification by establishing the authenticity of a specific

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physiological or behavioral characteristic possessed by the user [9].

The general structure of biometric recognition system consists of four main stages. First, the acquisition of biometric trait is process of getting a digitalized image of a person using specific capturing device [10] [11]. Second, the pre-processing is allowed to improve overall quality of the captured image [12]. Third, the features data are extracted using different algorithms[46]. Finally, the matching of the extracted characteristics is generally applied in order to perform the recognition of the individual [13].

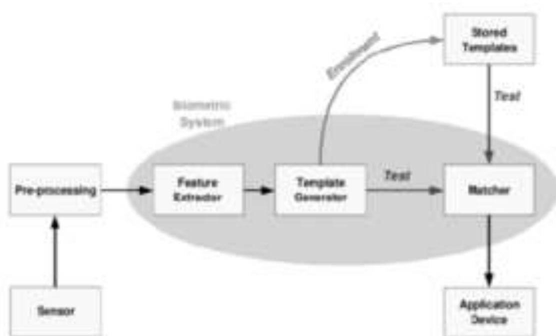


Fig 1: Generic Biometric Identification System

In recent years, with the development of artificial intelligence, scholars have made an attempt to apply machine learning method into finger vein recognition [14]. However, this method lacks robustness because of the low accuracy in the middle and small finger. In this paper, a new approach using CNN for finger-vein biometric identification was proposed, which reached a high accuracy and speed rate [15] [16].

A brief comparison of some of the biometric identifiers based on seven factors is provided in Table 1. Universality (do all people have it?), distinctiveness (can people be distinguished based on an identifier?), permanence (how permanent is the identifier?), and collectability (how well can the identifier be captured and quantified?) [17] are properties of biometric identifiers. Performance (speed and accuracy), acceptability (willingness of people to use), and circumvention (foolproof) are attributes of biometric systems [18] [19]. Use of many other biometric characteristics such as retina, infrared images of face and body parts, gait, odor, ear, and DNA in commercial authentication systems is also being investigated [20].

| Biometric trait | Main advantage | Defect | Security level | Sensor | Cost |
|---|---|---|---|---|---|
| Voice | Natural and convenient | Noise | Normal | Noncontact | Low |
| Face | Remote capture | Lighting conditions | Normal | Noncontact | Low |
| Fingerprint | Widely applied | Skin | Good | Contact | Low |
| Iris | High precision | Glasses | Excellent | Noncontact | High |
| Finger vein | High security level | Few | Excellent | Noncontact | Low |

Table 1 Comparison of different Biometric Identifications

In the traditional finger vein recognition, the main processes are: ROI extracting, filtering, noise reducing, image enhancing, feature extracting and distance matching [21][47][48]. However, it takes a long time in computing in the preprocessing stage, and different image sources are suitable for different processing methods [22]. So this paper proposed the finger vein recognition system based on convolutional neural network(CNN) , it can solve the problem of illumination change, scale transformation and image rotation, leading to an excellent performance on finger vein[49][50].

## 3. PROPOSED APPROACH

The development of the proposed finger-vein biometric identification system is discussed in two parts: the preprocessing stage and CNN design [23] [24]. Typical image processing designs require image preprocessing and segmentation to be performed before any further image processing and feature extraction process can be conducted [25] [26]. Preprocessing involves algorithms that include, among others, region of interest (ROI) extraction, image enhancement (denoising), and image normalization (resizing). Our approach does not require image enhancement since the CNN is robust to noise [26] [28][51]. The segmentation process essentially transforms the original image into a meaningful representation that is easier to analyze [29].

### Preprocessing stage

In the proposed system, image capture is done by placing a finger between an infrared light source and a camera [30] [31]. A near infrared light (NIR) with wavelength of 760–850 nm is transmitted from the back of the hand, penetrating deeply into the skin while the radiation of light is absorbed by the deoxyhemoglobin. When hemoglobin absorbs light, the finger veins appear as a pattern of shadows [32].

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These vein patterns are enhanced in the preprocessing stage of the design [33]. The finger vein recognition system proposed in this paper is shown in Figure 2.

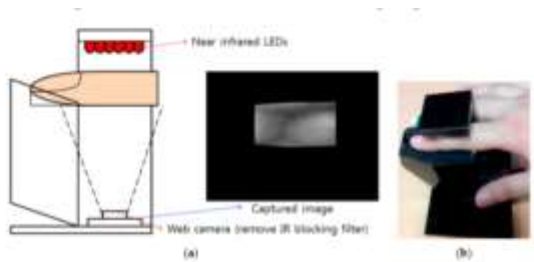


Fig 2 Working of Biometric Identification in Finger-Vein technology

In the registration phase, we capture the image of the finger vein by the device and get the region of interest(ROI), and then extract the feature vector through the CNN [34]. In the authentication phase, we use the same method to get the image and its feature vector [35] [36]. Then we calculated the Euclidean distance between the two vectors obtained above. If this distance is less than the threshold, it can be considered that two images comes from the same person and the authentication is successful, otherwise failed.

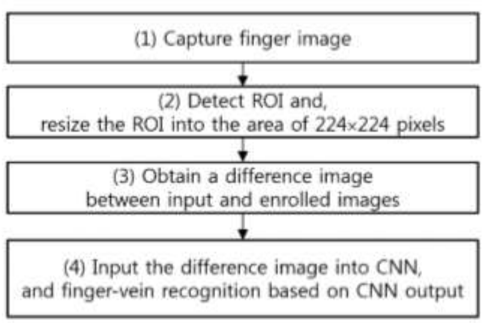


Fig 3:Working of the System

**CNN Based Architecture**

The finger vein image has the characteristics of location invariance and compositionality and the vein lines distribution of different people are similar [37]. And then the CNN model can be trained by inputting a large number of images so that it gets the ability to extract the most representative vector [38] [39]. When a computer sees an image (takes an image as input), it will see an array of pixel values. Depending on the resolution and size of the image, it will see a 32 x 32 x 3 array of numbers (The 3 refers to RGB values). Just to drive home the point, let's say we have a color image in JPG form and its size is 480 x 480 [41]. The representative array will be 480 x 480 x 3. Each of these numbers is given a value from 0 to 255 which describes the pixel intensity at that point.These numbers, while meaningless to us when we perform image classification,are the only inputs available to the computer [42]. The idea is that you give the computer this array of numbers and it will output numbers that describe the probability of the image being a certain class (.80 for cat, .15 for dog, .05 for bird, etc).

The main advantage of CNN compared to its predecessors is that it automatically detects the important features without any human supervision [43]. For example, given many pictures of cats and dogs it learns distinctive features for each class by itself.

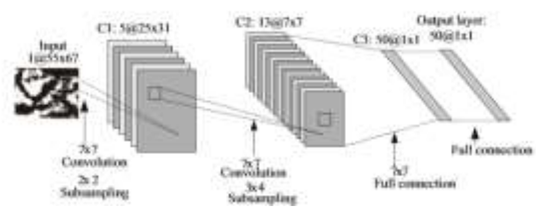


Fig 4 .Working in the CNN layer

## 4. EXPERIMENTAL RESULTS

**Experimental Set**

The experimental operation platform in this study is described as follows: the host configuration: Intel Core i7 − 4770 processor, 8Go RAM and NVIDIA GeForce GTX 980 4GO GPU, runtime environment: Ubuntu 14.04 LTS (64 bit). In order to better verify our algorithm, the following classification methods are adopted in the experiment dataset

Sample Code:

Input layer classifier.add(Conv2D(32, (3, 3), input_shape = (64, 64, 3), activation = 'relu')) classifier.add(MaxPooling2D(pool_size = (2, 2)))

classifier.add(Conv2D(32, (3, 3), activation = 'relu'))

classifier.add(MaxPooling2D(pool_size = (2, 2)))

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classifier.add(Conv2D(32, (3, 3), activation = 'relu'))

**Results**

```
Epoch 1/40
5/5 [==============================] - 1s 117ms/step - loss: 0.7211 - accuracy: 0.5500
Epoch 2/40
5/5 [==============================] - 0s 48ms/step - loss: 0.6908 - accuracy: 0.4500
Epoch 3/40
5/5 [==============================] - 0s 67ms/step - loss: 0.6826 - accuracy: 0.5000
Epoch 4/40
5/5 [==============================] - 0s 48ms/step - loss: 0.6665 - accuracy: 0.7500
Epoch 5/40
5/5 [==============================] - 0s 58ms/step - loss: 0.6433 - accuracy: 0.8500
Epoch 6/40
5/5 [==============================] - 0s 55ms/step - loss: 0.6404 - accuracy: 0.6500
Epoch 7/40
5/5 [==============================] - 0s 56ms/step - loss: 0.5723 - accuracy: 0.9000
Epoch 8/40
5/5 [==============================] - 0s 56ms/step - loss: 0.4389 - accuracy: 0.9500
Epoch 9/40
5/5 [==============================] - 0s 47ms/step - loss: 0.3909 - accuracy: 0.9500
Epoch 10/40
5/5 [==============================] - 0s 57ms/step - loss: 0.3345 - accuracy: 0.8500
Epoch 11/40
5/5 [==============================] - 0s 51ms/step - loss: 0.1522 - accuracy: 1.0000
Epoch 12/40
5/5 [==============================] - 0s 48ms/step - loss: 0.1042 - accuracy: 1.0000
Epoch 13/40
5/5 [==============================] - 0s 59ms/step - loss: 0.0412 - accuracy: 1.0000
Epoch 14/40
5/5 [==============================] - 0s 50ms/step - loss: 0.0158 - accuracy: 1.0000
```

Fig 5 Experimental Results

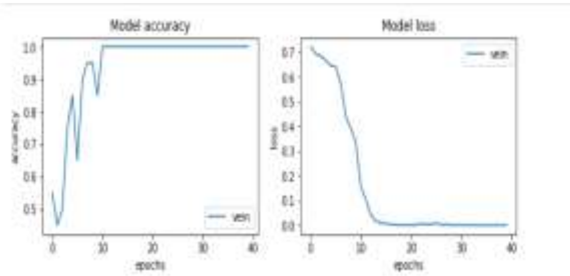


Fig 6 Accuracy and Error rate in test mode

## 5. CONCLUSION

Finger vein patterns are unique to each individual, even among identical twins. The false acceptance rate is very low (close to zero).Placing a hand or finger is less intrusive compared to other biometric technologies because veins are located inside the body, it is extremely difficult to read or steal. There is little risk of forgery or theft. Finger veins do not leave any trace during the authentication process and so cannot be duplicated. Finger vein patterns remain relatively constant through the adult years so that re-enrollment of the vein pattern will not be required once enrolled. Finger veins are less likely to be influenced by changes in the weather or physical condition of the individual. Rushes, cracked and rough skin do not affect the result of authentication. All the finger print based devices will be replaced by the finger vein verification system.

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