Palmprint recognition based neural networks

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Abstract

This paper contains palmprint recognition using Neural Networks. A very dynamic method of detection of key points is proposed for tracking Region Of Interest. The features are extracted by Principales Component Analysis and others filters technics. Artificial Neural Network is used as classifier. A program will be shown for a demonstration. It will be analyzed with the sight of its performances and its limits according to the made experiments. The various results will be discussed and at last some future works are proposed.

Keywords: Palmprint recognition, Artificial Neural Network, Pattern Recognition, Principal Component Analysis, Artificiel Intelligence

1 Introduction

The palm recognition is one of the most common biometric systems (Jaspreet Kour, 2013). (Adams Kong) present a variety of palm recognition systems. The richness of the characteristics of the palm print, compared to the other features, makes this biometric technique very competitive. In addition, in (ZHANG, 2012), it is noted that low-resolution techniques have been made. We will benefit from this work, to design our model, adapted to the means and the environment around us.

This paper is interested in a civil-use system, with neural networks. This work directly approaches the modelling of the program, whose algorithms developed during the studies have been implemented on Matlab. It is a very rich platform to satisfy our needs. We designed a model with 5 neurons. The rest of this paper is organized as follows: section 1, we will see the methods to model the palm recognition program. The completed program will be tested. We will dedicate section 3 and 4 to the experimentations and discussions, and conclusions respectively

2 Methods

Before approaching the heart of work, this part goes on a brief presentation of some notions.

2.1 Somes notions

2.1.1 ANN (Artificial Neural Network)

The works (François Blayo, 1996), (Richard P. Lippman, 1987), (Neural Networks : Biological Computers or Electronic Brains, 1990), (G. Dreyfus) and (Bessai F.Z.) were used to write this section.

The ANN can be used to solve a broad variety of problems. In ANN, we are always talking about architecture, learning and transfer function.

- Architecture

Some examples: the map of Kohonen (Figure 1), the multilayer perceptron (Figure 2) and many other architectures.

- Learning

There is two modes of learning: supervised and unsupervised. We will us the first mode.

- Transfer function

They can be sigmoid (II-1), hyperbolic tangent (II-2) or Heaviside step function (ll-3).

$$S = \frac{1}{1+e^{-x}}$$ **(Error! No text of specified style in document.**-1)

$$Th = \tanh(x)$$ **(Error! No text of specified style in document.**-2)

$$H = \begin{cases} 1, & x \geq 0 \\ 0, & x < 0 \end{cases}$$ **(Error! No text of specified style in document.**-3)

We will use a multilayer perceptron with supervised learning and sigmoid function.

2.1.2 PCA (Principal Component Analysis)

The works (Canu, 2017), (A.B. Dufour), and (Thulfiqar Hussein Mandeel) were used to write this section.

Statistics, data mining, dimensionality reduction, image compression: these expressions are enough to understand the role of the PCA in our work. La Figure 3 shows how it works.

We will use PCA for features extractions.

To understand the mechanism of the PCA, consider N palms of the hand $\{y_1, y_2, \dots\ , y_n\}$ aquired, m-dimensions and où C class contains each X image $\{X_1, X_2, \dots\ , X_n\}$.

Suppose the linear transformation that transforms large data into other data of greatly reduced n-dimensions

$m \ll n$ and the new vectors would be : $y_k = R^m$.

Soit :

$$y_k = W^T y_k$$ **(Error! No text of specified style in document.**-4)

Where k = 1,2, … , N – and W^T is the linear transformation.

2.1.3 SVM (Support Vector Machine)

The works (Méthodes avancées en décision), (Clémençon, 2011) and (Juan-Manuel RAMIREZ-CORTES, 2010) were used to write this section.

The SVM are supervised learning techniques designed to solve classification problems (linear : II-4, or non-linear : II-6). There are many methods used for classification: SVM, the ANN.

$$y = sign(h(x))$$ **(Error! No text of specified style in document.**-5)

Where $h(x) = \langle w + x \rangle + b = \sum_{i=1}^{n} w_i x_i + b$ **(Error! No text of specified style in document.**-6)

$$y(x) = sign(\sum_{i=1}^{n} y_i \alpha_i^* K(x_i x_j) + b)$$ **(Error! No text of specified style in document.**-7)

Où $K(x_i x_j) = \langle \phi(x_i), \phi(x_j) \rangle$ **(Error! No text of specified style in document.**-8)

h is the hyperplane (Figure 4).

- Margin

Originally, this technique is intended for two-class classifications. With the one-on-one method, it tries to separate the positive and negatives examples. The method searches for the hyperplane that makes this separation, guaranteeing that the margin between the closest to the positives and negatives is maximum.

Also, by the one-vs-all method (as opposed to the one-vs-one in two-class problem), the SVM can solve multi-class problems.

2.2 Modélisation du programme de reconnaissance palmaire

The process of palm print recognition includes 4 main parts (FAISAL, 2010) : IMAGE ACQUISITION, PRETREATMENTS (Kai-Wen Chuang), FEATURES EXTRACTIONS (Dapeng Zhang, 1999) , (Line Hand Feature-based Palm-print Identification System Using Learning Vector Quantization, 2016), (Boukhari Wassila) and IDENTIFICATION.

Experiences were tried on 6 (recognized) and 3 (unrecognized) individuals.

Here is a summary of the registered and unregistered individuals (**Error! Reference source not found.**).

2.2.1 Image acquisition

We used a smartphone, in color at 5 MégaPixels. (Figure 5)

2.2.2 Pretreatments

- Binarisation

Turning the image into a binary type makes it much easier for some operations. This process can be translated by a low pass filter applied to the acquired image [20] :

$$binary\ (x,y) = \begin{cases} 1, & image(x,y) * L(x,y) \geq Threshold \\ 0, & image(x,y) * L(x,y) < Threshold \end{cases}$$

(**Error! No text of specified style in document.**-9)

In its implementation :

- We go first through a conversion of the image to the grayscale (Figure 6),
- Then convert the image to the grayscale in a binary image (Figure 7).

- Standardization

- Check if the palm image is right, and line up if needed. It is a matter of drawing a right passing by 2 points to 2 specific places of the hand, we check the slope of the right. Correct the angle of this slope is to align the acquired image.
- Adjust the image resolution to the original size.

- Key points detection

- Draw the outline on the binary image (Figure 8),
- Find the center of gravity of the area,
- Ignore (at this step) the part of the hand from the center of gravity to the wrist,
- Consider each pixel of the contour as the center of a circle: evaluate the number of points on the circumference of the circle belonging or not to the region of the hand. So either the pixel is a key point or else, proceed to the next pixel along the outline.

- Tracing the ROI

- When the key points (Figure 9) are detected, connect them to establish a coordinate system (Figure 10),), forming 2 axes X and Y,
- Trace the ROI (Region Of Interest) (Figure 11),
- Cut this region.

2.2.3 Features extractions

- **Turning** the ROI color to ROI in gray level,

- **Reducing** the size of the image of the ROI to a standard set to standardize the data,
- **Filter series**: noise suppression, features uprising,
- **Deducing** a vector representing the ROI with PCA,
- **Designing** a matrix with all the vectors, and create a database for learning at the ANN (Artificial Neural Networks).
- Here completes the record an individual.

2.2.4 Identification

Almost the same procedure as extracting the characteristics, except that instead of going into learning, the matrix is submitted to the network for an identification.

3 Results

The demonstrator is very simple to use, it contains 3 tabs freely according to the user:

- The "Home" tab is represented in Figure 12,
- The "Demo" tab (Figure 13) is the heart of the operations. As you can see, this tab contains 2 buttons :
- **Open picture** : allows to open the file explorer to choose a picture of palm print (Figure 14),
- **Identification** : allows you to launch the recognition of the selected image.

Then there are 3 objects representing the figures, from left to right:

- **Result** : here is indicated the class of the individual. If the individual is recognized (belongs to the base), his class and recognition index are displayed in percentages. And if the individual is not recognized (does not belong to the base), it indicates zero and shows -1 in the recognition index box.
- **Image ROI** : when the ROI has been cut, it will appear here.
- **Palmprint Image** : shows the image of the selected hand with the "Open Picure" button.

After pressing the "Identification" button, after 2.5 seconds, the system gives the result (Figure 15).

Note that this time is only true for the images taken by scanner that we have obtained by online bases. For the images taken by the smartphone, the program takes more time to perform the recognition, this is due to the difference in quality. The image taken to the scanner is of better quality. Thus, it can be treated with low dimensions (640x480), while the image taken by the phone should be treated with large dimensions. What is further verified by the time of running the program in this case: about 15 seconds.

If the individual is not recognized, the demonstrator displays 0 as a result and -1 as a recognition (Figure 16). There are, however, cases where the demonstrator is not able to successfully complete the recognition task. Here are some examples (Figure 17 et Figure 18).

After analysis, here are the reasons why the program failed in these cases :

- **Case 1** : The middle finger and the ring finger are too close to each other, which distorted the detection of the key points and the ROI. As the (Figure 19) more clearly shows. In this case, the program was able to complete the task but incorrectly.
- **Case 2** : In this case, however, the program has not even been able to complete the task, there are 2 problems of which one is the orientation of the image. The other is

explained by the Figure 20. In this case, even pointing in the right direction, the image could not have been recognized because the binarisation failed.

4 Discussions

After several tests, our result satisfies us with a recognition rate of 9/9 (6 recognized as registered, 3 recognized as unregistered).

But this result is reliable only for our work because there is still too little data processed in learning bases. We see that the behavior of the network varies in some learning. If you take photos in a variety of conditions, you don't get the same rate, because the quality of the image of our smartphone is sensitive to the brightness, so the program too. With a considerable size of data one can make take with varied conditions, because all these details will be considered during the learning. But also with improved techniques, such as coupling recognition with the capture of the venous network, one can remedy problems such as changes in the image of the palm of the hand because of the formations of wrinkles, wounds, aging… However, more adapted material will be required. The simple photo-taking system does not allow the capture of the veins to be integrated. Whatit can also be said that the characteristic extractor allows us to complete a reconnaissance task with only 48 images, even if it is limited by some conditions. But the highlight of the program lies in the extractor of the ROI which is very flexible, the removal of background works on just about any dark background or dark color. In cases where it fails, it is when the palm of the hand presents pixels of values substantially equal to the background, the common cause of this dysfunction is the brightness.

Also we tested our program using the SVM as classificators, with the same data, and we got a result of 8/9 (6 recognized as registered, 2 recognized as unregistered, and 1 incorrectly recognized as being registered).

5 Conclusion

Our program of PalmPrint recognition completes its work. Our characteristic extractor is effective, even if it is subject to the conditions of the brightness, the orientation of the hand and an effective relationship of the ANN/learning bases. But as discussed, there are solutions.

For example, on the one hand a more substantial database of data, on the other hand a development of techniques, with adaptation of the image capture material for this purpose.

Our program can also work using the SVM classifiers, which is not bad. Our program has assets, other than the network of neuron.

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6 Tables and Figures

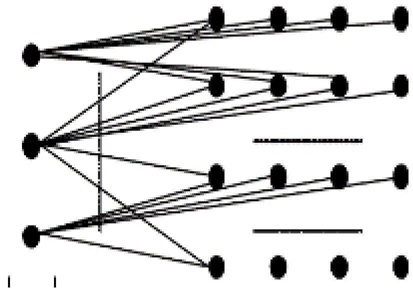

Figure 1 : Kohonen map

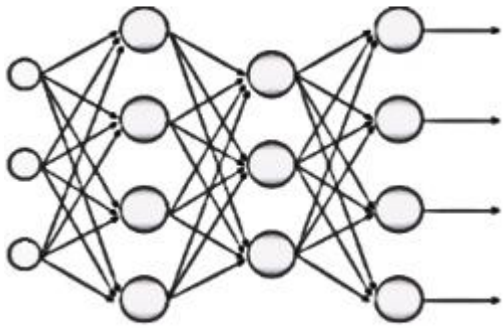

Figure 2 : Multilayer Perceptron

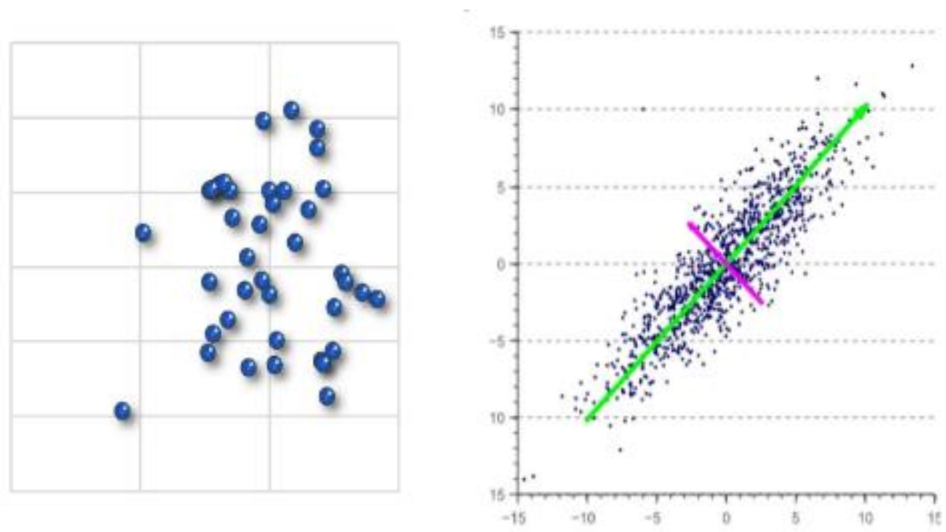

Figure 3 : Mecanism of the PCA

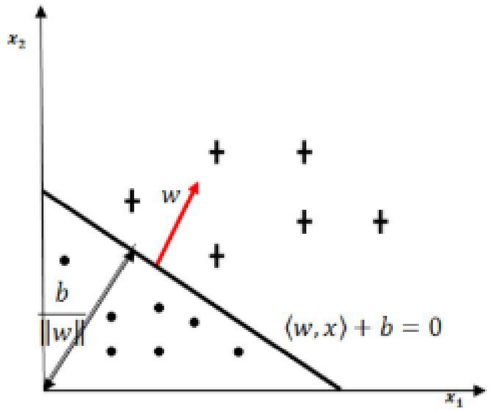

Figure 4 : Hyperplane ⟨w+x⟩+b = 0

Figure 5 : Picture taken by a smartphone

Figure 6 : Picture in gray level

Figure 7 : Binary Image

Figure 8 : Picture with contour

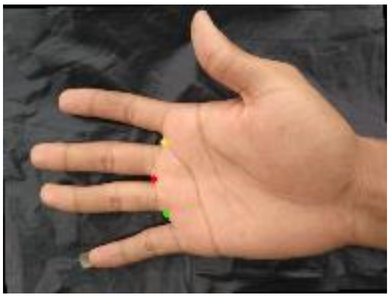

Figure 9 : Picture with key points

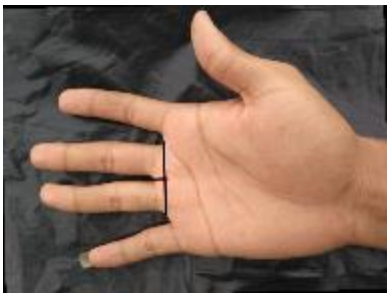

Figure 10 : Image with coordinate system

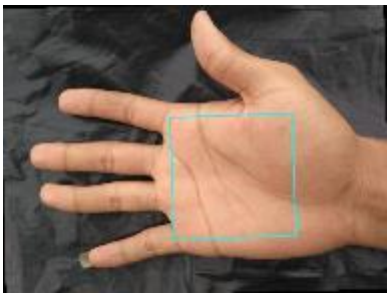

Figure 11 : Image with ROI

Figure 12 : Palmprint Recognition Program: "Home "

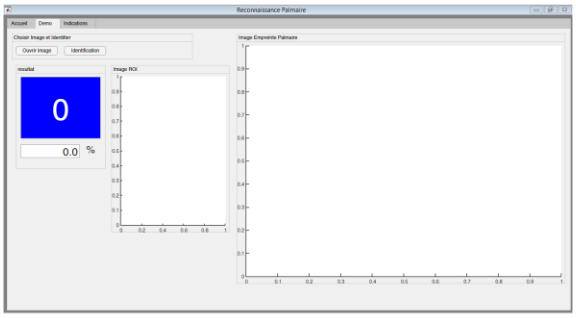

Figure 13 : "Demo" interface

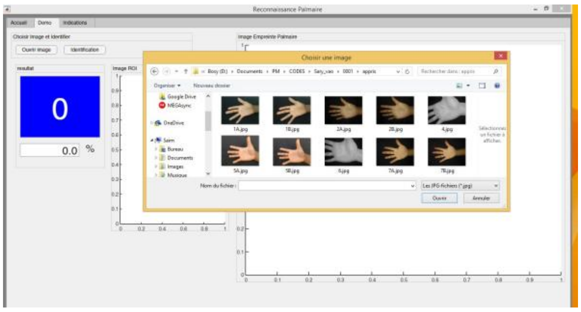

Figure 14 : " Demo" interface: Open image

Figure 15 : "Demo" interface: Identification - recognized case

Figure 16 : "Demo" interface: Identification - case not recognized

Figure 17 : Failure to identify (1)

Figure 18 : Failure to identify (2)

Figure 19 : Left to Right: Binarization - Key Points - ROI

Figure 20 : Incorrect Binarization

Classe (individu)	Enregistrement
1	YES
2	YES
3	NOT
4	YES
5	YES
6	YES
7	YES
8	NOT
9	NOT

Tableau 1 : Referencing for the consideration (registered or not