Use the palmprint for identification and authentication of persons: a new real-time method of data treatment based on graph construction of spatial interest points

Alain Simac-Lejeune
Compilatio
276, rue du Mont-Blanc
74540, Saint-Félix, France
alain@compilatio.net

ABSTRACT

The identification and authentication of individuals by their palmprints is a recent approach in the family of biometric modalities, very interesting in appearance and non-contact non-intrusive. It was recently studied in topic research over the last decade. The proposed approaches are mostly based on methods of classification and learning. However, the complexity of the calculations leads to an inappropriate application in real time. In our work, we investigated the use of basic primitives pictures more precisely the Space Interest Points (SIO) in a real-time process of identification and authentication of palmprint. This process is based on construction and matching of graph. By setting few constraints and working with matching methods and matching specific, experimental results suggest a robust real-time solution as good as the best methods with an error rate authentication below 1% for a population of 20 individuals.

Keywords

interest point, biometrics, palmprint, identification, authentication

1. INTRODUCTION

Securing property and data is a very important topic. An effective way to perform the security is the use of biometric characteristics that is unique to each individual. Thus, there are physical characteristics such as fingerprints, palm prints, DNA, iris, retina, facial features, the morphology of the hand, the spectrum of voice, smell and even the veins hand but also behavioral characteristics such as keystroke dynamics, the dynamics of signatures or of the voice. However, any identification system is based on one or more characteristics selected under specific parameters:

- **universality**: each individual must possess the characteristics;
- **singularity**: it is possible to separate individuals from each other;
- **continuously**: resilience in everyday life and aging as well as intentional or unintentional alteration;
- **collectability**: ease of acquisition of the measure;
- **performance**: accuracy, speed and robustness of technology used;
- **acceptability**: degree of approval of the technology;
- **bypass**: ease of use of a substitute.

In the palmar recognition, the conditions are the same as for fingerprints (they are unique for everyone, including identical twins). Moreover, this method has many advantages. First, the capture system is cheaper than for iris recognition, the features of the hand are more numerous than those of fingerprints and can be determined with low resolution images. The system has a very important level of acceptability. The bypass is rare because it usually does not have a photo of the palm of his hand and it is difficult to take pictures without the knowledge of a person. The bypass is unlikely. However, when it is made, there is more possibility to use the system. Finally, this type of system is advocated in France by the *Commission Nationale Informatique et Libertés*.

Our goal is to establish a fast approach (near in real-time) for a web context while using an equipment inexpensive and available to all: the on-board cameras in computers (the most are in a resolution at least of 0.3 million pixels).

In this paper we propose a recognition method of hand without contact. The Section 2 presents the state of the art in the palmar area of recognition. Section 3 describes the feature extraction of the palm. Section 4 describes the process of creating the graph, the algorithm for generating and matching method. Section 5 and 6 show respectively the experimental results and give conclusions.

2. STATE OF ART

Biometrics tries to answer to two operations: the verification and the identification. The verification is the comparison of a captured biometric data with a stored template to verify that the individual is who he claims to be. The identification is realized by comparing a biometric data captured with those present in a database in order to identify an unknown person. Many systems have been proposed to perform the identification based on biometric characters and especially around the hand. Some previously methods use the recognition of the shape of his hand that is rely only on the geometry of the hand (Kumar et al., 2004). Its use 90 characteristics to create a three dimensional shape of the hand, the length, width fingers and especially the shape of the joints, but these methods require expensive equipment and generally require a contact between the device and the hand. So, quickly, the idea emerge to use palm prints to identify individuals.

Methods for authentication based on the palm of the hand (a state of the art is available in the publication of Kong et al., 2009 with all references in the assessment section) are approaches based on the lines of the hand.

There are also methods based on the binarization of Otsu and characterizations of hierarchical texture. In most of these methods, the computation time is important and images of palm used are of good quality. In a context of fast authentication via webcam, these are the two constraints that must be raising.

3. INTEREST POINTS AND GRAPH

Spatial Interest Points

In 1988, Harris (Harris et al., 1988) is an extension of the 2D gradient to highlight points of interest space (SIP noted for "Space Interest Points") defined as points where appears an evident change of marked in the image. For example, corners, intersections, points and isolated points on textures are specific points of interest. In practice, these points of interest correspond to a pixel having a large curvature radius of the intensity and is in a second order variations. The SIP is defined from the Hessian matrix H like:

$$M(x,y) = I(x,y) \times \begin{pmatrix} \frac{\partial^2 G_S(x,y)}{\partial x^2} & \frac{\partial^2 G_S(x,y)}{\partial x \partial y} \\ \frac{\partial^2 G_S(x,y)}{\partial x \partial y} & \frac{\partial^2 G_S(x,y)}{\partial y^2} \end{pmatrix} \quad (1)$$

with I (x, y) representing the intensity of a pixel of coordinates (x, y) in the image I G_S and (x, y) represents the impulse response filter performing Gaussian smoothing, mitigates the importance of the noise generated by the operations branch, and introduces a notion of scale factor. The extraction of points is carried out using a criterion of salience such as:

$$\mathrm{R(x,y)} = \det\big(\mathrm{M(x,y)}\big) - \mathrm{k} \times \mathrm{trace}^2(\mathrm{M(x,y)}) \quad (2)$$

where k is the parameter used to manage the detection sensitivity of landmarks. Typical values of k are usually chosen in the interval [0.04, 0.15]. According to several authors, the experiment shows that a good value is obtained for a k about 0.04 (recognized as the best value in the community without any reference available on this).

Rooted Tree

A rooted tree is a directed acyclic graph with a single root, and such that all nodes except the root have a single parent. This structure allows the use of recursive and technical courses in width and in depth. The root is the only node with no parent. The nodes are interconnected by an edge. The depth of a node is the distance, i.e. the number of edges from the root to the node. The height of a tree is the greatest depth of a leaf of the tree. The size of a tree is its number of nodes (counting the leaves or not).

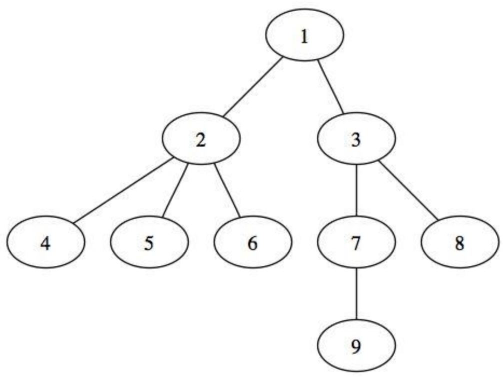


Figure 1. Example of rooted tree with 9 nodes (1-9).

4. APPROACH

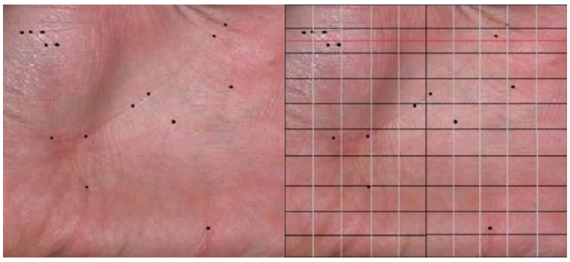
Two phases are considered: the insertion phase of a new identity in the system and the recognition phase of an individual. The insertion phase is to take multiple images of the palm of the hand and to extract the characteristic used to construct a signature. In our case, a signature consists of spatial landmarks to establish a particular graph (a rooted tree). This graph represents the stored signature. The recognition phase is to extract features, and then build the signature matched the search.

Signature creation

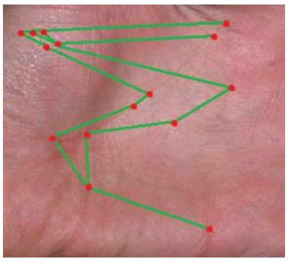
The extraction of landmarks is performed after pretreatment of isolating the hand to his environment (Fig. 2 - step 1). In this step, the hand is systematically rotated (continuous range of angles of rotation) to be always right fingers (arbitrary choice), which can be insensitive to the shooting conditions. The segment to retain only the main square in the palm of the hand (Figure 2 - step 2). This step is performed automatically using the method of (Doublet et al., 2006).

On this image we extract points of interest (Fig. 2 - step 3) with the following parameters: 1.5 for the sigma space and an adaptive threshold in order to obtain a maximal number of 25 points (usually around 180).

1. hand capture 2. zone segmentation



3. interest points 4. cutting block



5. creation of the signature

Figure 2. The different steps of the signature extraction of palmprint

The construction of the signature requires the establishment of a rooted tree from the interest points. The lowest point is considered like the root. Segmentation is realized horizontally and vertically into 10 zones allowing the construction of 100 cubes (Figure 2 - Step 4). We build from a point using the following algorithm:

Algorithm 1 Creation of palmprint signature from SIP

```
for all line L do
    if NBpoints[l] = 1 then
        if NBpoints[l+1] = 1 then
            createLink(l,l+1)
        else
            for all points P (l+1)
                createLink(l,P)
            end for
        end if
    else
        if NBpoints[l+1]=1
            createLink(l,l+1-left)
        else
        if NBpoints[l]=NBpoints[l+1]
            then
                for each point n
                createlink(l_n,l+1_n)
            else
                for each point n
                createlink(l_n,l+1_n)
                and
                createlink(l_max,l+1_n)
            end if
        end if
    end if
end for
```

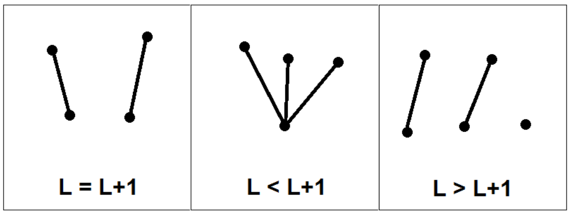


Figure 3. The various cases of production between lines

There are three cases of number of points of the line L: it is the same than that of the line L+1, it is greater than that of the line L+1 and is smaller than of the line L+1 (Fig. 3). We finally obtain a rooted tree (Fig. 2 - step 5) that represents the signature of the palm of the individual in question.

Recognition of a signature

Several methods can be used to recognize a signature: the matching of graphs, the pattern recognition... We chose initially to use the specific algorithm (Peura, 2001) that allows mapping graphs with a very low cost. Further, it takes into account the type and provides a distance between trees allowing favoring speed of execution always with a view to obtain a real time system.

5. EVALUATIONS

To perform the evaluation of our method, we compared it to existing methods (Table 1). A database was developed specifically to validate our approach. The images were acquired with a Logitech webcam C500 at resolution of 1280x1024 set to capture at 640x480. The database contains 200 images from 20 individuals (10 women and 10 men ranging from 18 to 50 years) and 10 frames per individual. That is to say a database similar to almost all those used in the cited literature since their foundations were not directly accessible.

For all tests presented, the conditions are the same: plain background and light well known despite in our framework, it will need to be robust even in less favorable conditions. Finally, our approach shows interesting performances compared to other methods including the number of images required and the error rate.

Method	***Compare***	***U/A/E***	***TER***	***REF***
Ondelette	Euclidien	200/5/1	0.5%	Wu2002
LDA	-	300/10/-	0.82%	Wu2003
PCA	Euclidien	382/8/4	0.85%	Lu2003
ICA	Neurone	100/6/-	1%	Lin2010
Gabor	Euclidien	80/10/1	2.5%	Kumar2004
Ondelette	Manhattan	50/4/1	2%	Zhang2004
Gabor	Euclidien	80/10/1	1.6%	Kong2004
Filtrage	Euclidien	320/10/6	2.08%	Wu2004
Morpho.	Hamming	100/10/6	1.96%	Wu2005
Hu	Euclidien	189/10/2	1%	Noh2005
Gabor	Hamming	398/20/1	0.31%	Zhang2004
LBP	AdaBoost	50/10/2	2%	Wang2006
Hough	Hansdorff	100/6/3	1%	Li2006
Your	**Euclidien**	**50/4/3**	**0.54%**	-

Table 1. Comparison of palmprint recognition methods. A is the number of acquisition, by user U and E the number of images for enrollment. TER is the equal error rate.

6. CONLUSION

In this paper, we investigated the use of biometrics and more particularly palm prints in order to perform identification and authentication of persons. The proposed approach, based on points of interest usable space in a web context, shows interesting results since it is rather reliable (low TER) and it has a rather low computation time. Finally, we can conclude that the proposed method with palmprint recognition is sufficiently robust and powerful to be used as a means of secure systems without the need for specialized equipment. It is now necessary to evaluate the system in a broader context and in less controlled conditions to validate its relevance.

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