Authentication Method Using Hand Images for Access Control systems

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Abstract: *The encroachment of information is considered the most important attack that affects the performance of the network. Biometric based authentications have emerged as promising components of information security. Biometric is used for two major purposes: identification and authentication. We propose a palm based authentication method that uses hand images to define a set of referencing points considered as invariable and unique in the authentication process. The method of circular histogram analysis has been used to enable the definition of the angular orientation of palm representation and the corner of turn where it is necessary to turn the image for correct determination of supporting points which is based on two-dimensional discrete differentiations of image with the next analysis of given points of brightness projections forming the curves of peaks and cavities of hand- fingers and facilitating the searching process for such given points. The system of signs-recognition, which allows authentication of identity, regardless of palm location and its position within the limits of the scanning field has been used and proved to be economic and capable of improving the operability of the authentication system.*

Keywords: *Recognition system, hand image, control access system, invariance affine transformation*

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1. Introduction

The task of human recognition is a very old and at the same time quite actual. Nowadays this problem is solved by the application of biometric. From the technical point of view, biometric is "the automated technique of measuring a physical characteristic or personal trait of an individual and comparing that characteristic to a comprehensive database for purposes of identification". Along with the development of computers more attention has to be paid to the new methods development of images processing and authentication in the biometric computerized systems (BMI) designed to perform an exploit of access control. The world market of such systems intensively develops and offers to users more sophisticated systems. It is well known that BMI Systems identifies a human personality with physical and personal characteristics: eye's features (iris, retina), facial features, hand geometry, ear shape, fingerprints, wrist/hand veins, DNA, chemical composition of body odor, handwritten signature, keystrokes/typing patterns, voiceprint etc. All these physical and personal characters are measured and integrated into computer system for concerned person recognition. Thus biometric authentication is used for two major purposes: identification and authentication. Among the existing BMI Systems the great interest is devoted to the hand (palm) authentication. Recently finger-prints authentications has shown to work well in most cases; however, a large segments of users, such as elderly people and manual laborers, fail to deliver good quality finger prints that pose some limitation about the uses of these methods for authentication or security control. For that it is necessary to find another authentication mechanism. Many works have been done in this context [4, 8], all were focused on the methods of description and authentication of biometrical images that are not invariant to affine transformations. Many physiological characteristics of humans, biometric, are typically time invariant, easy to acquire, and unique for every individual. Such as face, finger print, hand geometry. In this paper we propose an authentication mechanism that uses the hand geometry obtained from a hand image to identify the person that access the system. Our algorithm works on considering a set of noticed points in palm like tips of fingers and finger-valley and the center of the palm as input. Taking in consideration that these points are principal points and lines between them are invariant. Then some calculations are done on the input data to define the class of hand on which it belongs. Our authentication mechanism differs from that proposed in [6], in the measures used as input, where in our work the center-life of the hand is defined previously as point a_0 to which measure all the other referencing points. And the fingers used in our work are five fingers considering that the distance between the thumb and the index is one of the measures that identify the hand. Some other biometric used in the authentication method like finger width and thickness can vary with the time given age, profession, and body structure (thin, fat).

In[6], is proposed an authentication mechanism that is based on the extraction of hand geometry features using total of 16 features distributed as 4 fingers-lengths, 8 finger-widths (2 width per finger), palm width, palm length, hand area, and hand length. That means every hand image is characterized by a vector of length 1x16. Then a set of fusional operations are done on this vector to find similarity between this vector and the shared identity. This similarity is considered as matching score. These measurements define the correlation between the considered vector and the other vectors stored in the data base to indicate his/her identity. If matching score is less than a specific threshold, then the user is assumed to be imposter. Else it decides him or her as genuine. In [7], is proposed a palmprint and hand geometry images mechanism that extracts the information from a hand image in a single shot at the same time. In this method the grey level hand images of every user are acquired from a digital camera and used to extract automatically the palmprint and hand geometry features. These images are first binarized by using global thresholding. The resultant binary image is used to estimate the orientation of hand. The rotated binary image is used to compute hand geometry features. For the palmprint feature extraction is identified the principal lines and creases that offers high accuracy in palmprint verification and that is done by normalization of the palmprint binary image. For the extraction of hand geometry features as length and width of fingers. The binary images is used to compute a total of 16 hand geometry features are the same presented in[6], The length of fingers are efficiently computed by defining a pair of control points in binary image.

In [3], is proposed a scanner based personal authentication system by using palmprint features. The authentication is done in two stages are enrollment and verification. In the enrollment phase a set of hand images are collected and processed to extract a matching temple, where identified a square region in a palm which is called region of interest on which it applied the extraction process to obtain the feature vectors. In the verification stage the extracted modules are compared with the templates to decide whether matching or not. It is used the neural network to measure the similarity between the reference templates and test samples.

2. Proposed Algorithm

Our algorithm is based on using a set of fixed points in hand images and to use them as input for the identification process. We have taken a set of hand images which is defined the referencing points that are considered unique and fixed for each person. Then the palm print is divided into segments using algebraic method [2], and by doing some calculations on these segments we can define the class of hands to which it belongs. This work is done in different steps, first hand-phase analysis in which it extracts the referencing points, then the segmentation phase and finally the authentication phase.

2.1. The Extraction of Informing Features

To form the authentication features the points of control (references points) are divided into two groups:

- Points corresponding to the bottom of the inter finger valleys $a_1 \ldots\ldots a_6$
- The second group of points are the tips of fingers $b_1 \ldots\ldots\ldots b_5$. Thus :

$$A = \{a_i\} \quad i = 1..6$$

$$B = \{b_j\}, \quad j = 1..5$$

Given an image Z_1, our algorithm A_t must be able to find (A, B) where (A, B) = A_t (Z_1), the set of referencing points of Z_1.

- Another important point is added to the previous referencing points used in the identification process is a0 the center life of the hand (figure.1).

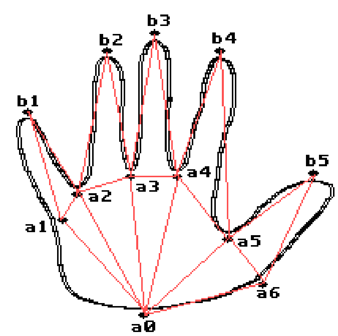


Figure1. The extraction of referencing points.

2.2. The Segmentation Phase

For the identification process a set of measures is taken are:

- The distance between fingers
  $x_i = d(a_i , a_{i+1})$ i= 1….6
- The external distance between the bottom of the inter finger valleys and the tips of fingers
  $Y_{ij} = d(a_i , b_j)$ i = 1……6, j=1……5
- The internal distance between the bottom of the inter finger valleys and the tips of fingers.
  $Y_{kj} = d(a_k , b_j)$ k = i+1, i= 0……6, j =1…5
- The distance between the center life of the hand and the bottom inter finger valleys

Y0i = d(a0 , ai) i= 1…..6 this distance must identify the core of the palm.

Figure 2, explains the segmentation process, it is clear that the hand is transformed to a graph where the nodes are the referencing points and the edges are the distances mentioned previously.

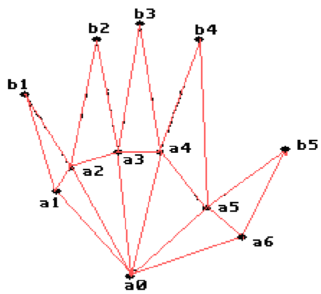


Figure 2. The segmentation process.

2.3. Authentication Process

Given a vector X={x_i , Y_{ij} , Y_{kj} , Y_{0i} }, is used the learning with teacher method tp map this vector into a matrix T that consists on N columns and n rows, to obtain the output vector O(O_1 , O_2 ,……O_N) that defines to which class of images the input vector belong. T represents a class of objects called Teaching table $T = \left\| T_1, T_2, ..., T_n \right\|^T$. T is a sectional matrix that consists on N sections, every section T_i i=1…….N is a matrix that consists of N columns and n_i rows. The input X is confronted with the elements of T using the algorithm A_L to obtain the estimation vector

$$O=(O_1,\dots O_N)=A_L(X, T).$$

That means given the input object X and the teaching table T a class O is determined and mapped on the class of images K.

The flowchart in figure.3, describes the authentication process. A_L represents the step of the algorithm that maps X into teaching table. A_F is the mapping of the results in the vector O and A_R represents the final step that maps O in K the hand image classes.

3. Implementation

3.1. Analysis of Hand Image.

This method consists of input image segmentation received as a result of hand scanning, determination of its angular position in relation to a center with a next rotation by an angle which is determined by the method of circular histogram analysis[9]. The choice of segmentation algorithm among the set of the designed algorithms takes place on the basis of the application of the developed criterion of segmentation quality. The essence of the given criterion consists in estimation of quality of the segmented image, based on the quantity of the selected objects (segments) and their area.

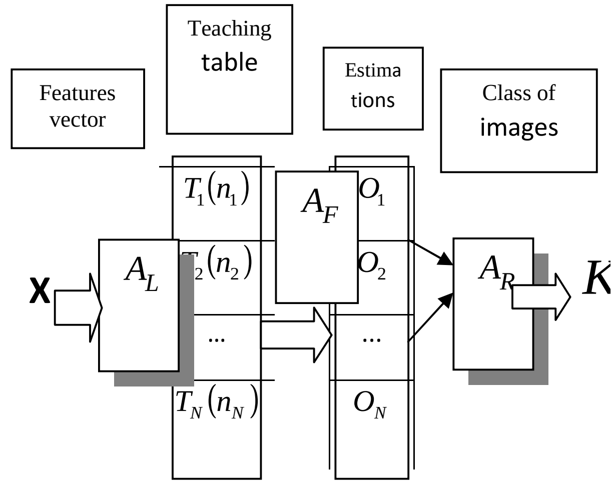


Figure 3. The flowchart of the authentication process.

If a result of segmentation is one object (segment) appeared and its area makes 35-45% from the total area of image, then it is considered that the segmentation is conducted successfully. In the fig .4 the result of segmentation by a threshold method is shown. One object with the relative area 47.17% appeared. The operation of segmentation is conducted unsuccessfully if a few (>1) objects (segments) are received. Their area makes no more than 2% of the total area of image. In fig .5 the result of image segmentation with threshold method is shown with incorrect choice of threshold value. As a result of successfully conducted segmentation an object the angular orientation of which relatively to the center of image is not always identical is received. As the correct determination of points of control takes place only at its given position, therefore, for determination of angular orientation of hand it is suggested to use the method of circular histogram analysis which provides the invariance of authentication method to the image rotation.


Figure 4: Result of satisfactory segmentation

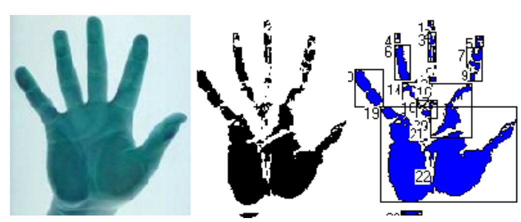


Figure 5: Result of unsatisfactory segmentation

3.2. Implementation Of Hand Based Authentication

The Flow chart in figure 6 represents the implementation of the authentication algorithm proposed

3.3. Determination Of Object Angular Orientation

The rotation by the given angle is determined by the method of maximum of circular histogram [1,11,8]. In Fig.7(a) the segmented image to be rotated by a determined angle is shown. Fig.7(b) represents its circular histogram determined as a sum of pixels of object in every column of image for the given angle α. Determination of peaks is carried out by the change of angle from 0 to 360^{o}.

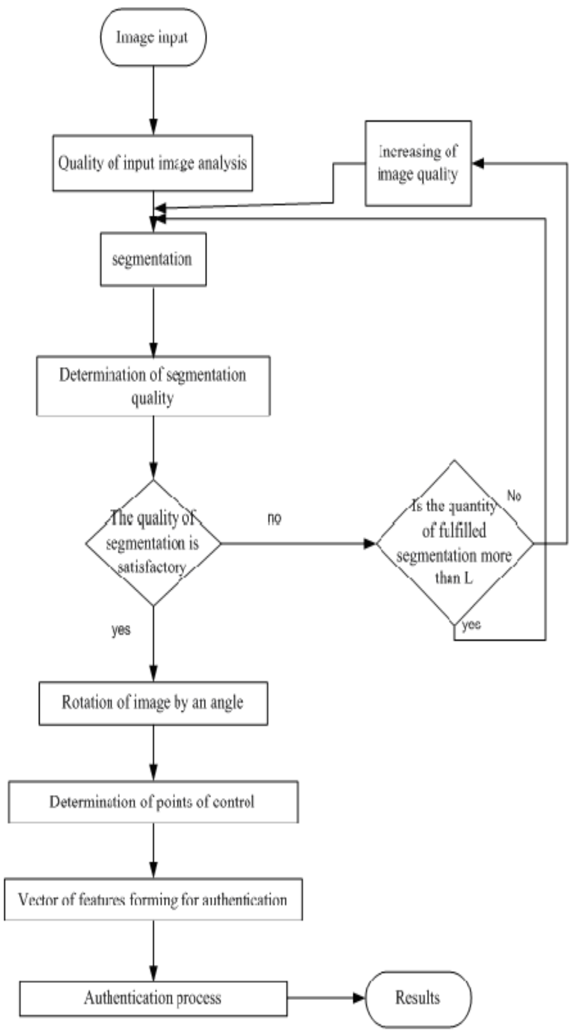
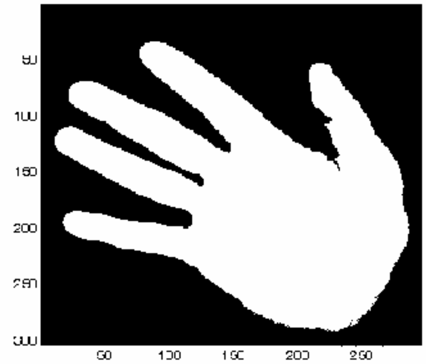
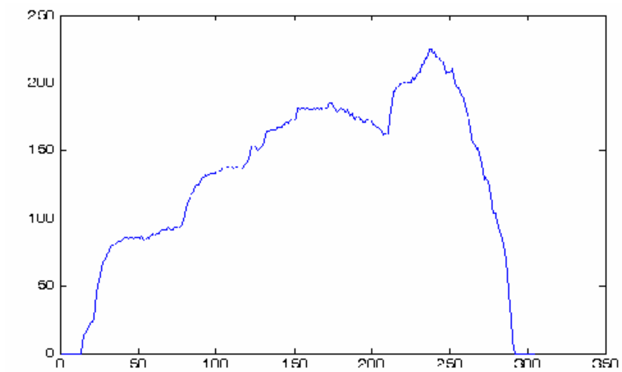


Figure6. The implementation of the proposed algorithm.



(a) The segmented hand image.



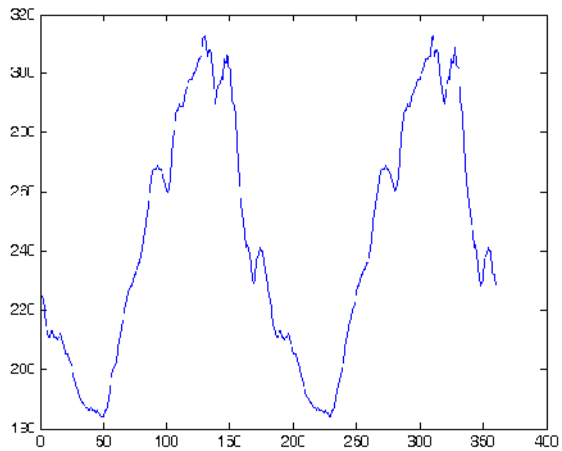
(b) Circular histogram for angle $\alpha = \mathbf{0}^{o}$.

Figure 7.

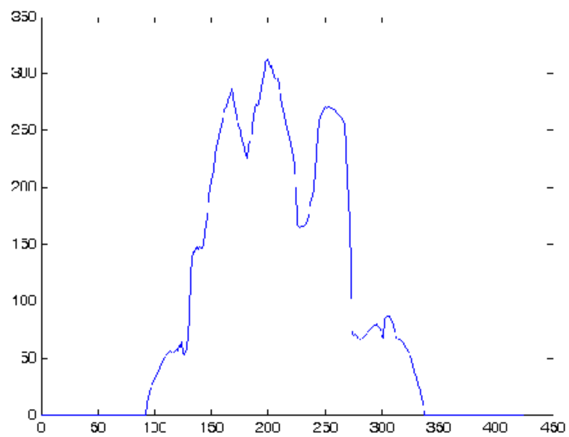
In figure 8(a) dependence is shown. Maximum of this function is 225. Analyzing the presented dependence it is possible to see the two identical peaks. The first one is achieved by the angle of rotation $\alpha = 130^{o}$, and second one by the angle $\alpha = \mathbf{310}^{o}$. The rotation takes place to the right-hand. In fig.8b a circular histogram is shown for the angle $\alpha = \mathbf{310}^{o}$.

3.4. Determination of control points

With the methods of two-dimensional discrete differentiation which is executed by means the operation of convolution of array of image with course gradient masks. The use of Previtt mask allows to expose the vertical difference of brightness that are in this case the curves of finger tips and finger valley. In fig.9 the result of convolution of image is shown with the Previtt mask. Determination of points of curves takes place by a threshold method. In fig.10 the curves of fingers tips and valleys are shown. To find points of control of skeleton model the analysis of curves for determination of extremum is used. The values of coordinates of maximums and minimums of each curves are taking as values of coordinates of points of control of the model.



(a) Dependence of maximal values of angular histogram by the angle of rotation.



(b) Circular histogram for the angle $\alpha = \mathbf{310^{o}}$.

Figure 8

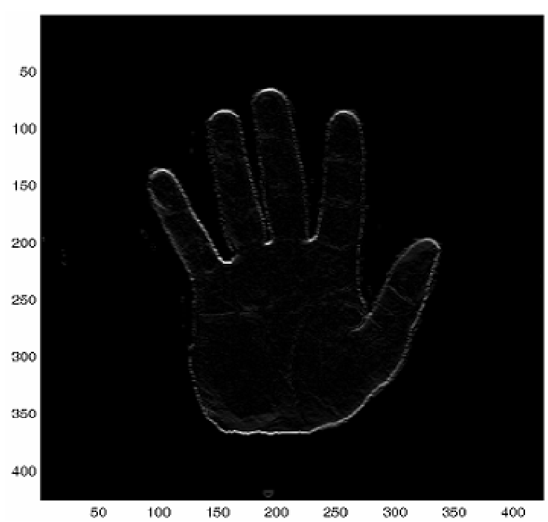


Figure 9. Determination of vertical difference of brightness.

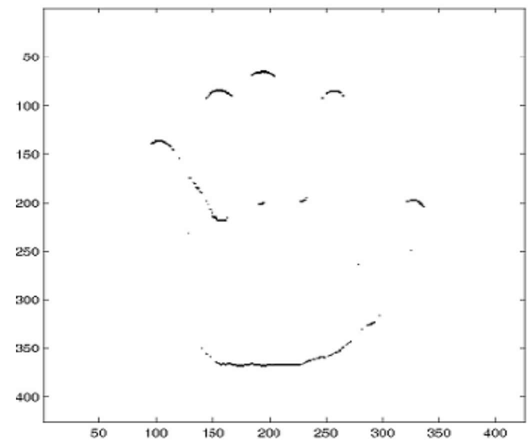


Figure 10. Curves of finger tips and valleys.

3.5. Calculation of Authentication Features On The Basis of Points of Control of Skeleton Model

Sides of triangles presented each fingers is determined for this purpose. There are such triangles $\Delta a_1 b_1 a_2$, $\Delta a_2 b_2 a_3$, $\Delta a_3 b_3 a_4$, $\Delta a_4 b_4 a_5$, $\Delta a_5 b_5 a_6$ in figure 2. The triangles related to the point a_0 are not considered as the authentication features for them are carried a little information as a result of ambiguousness of determination of this point. As authentication features lengths $a_1 a_2$, $a_2 a_3$, $a_3 a_4$, $a_4 a_5$, $a_5 a_6$ are also chosen as well as medians of each of triangles dropped from corners b_1, b_2, b_3, b_4, b_5 . As a result we get the vector of features for each image that consists of ten numbers.

4. Conclusion and Future works

In this paper we have been proposed an approach for palm authentication based on the measuring and the calculation of the distances between invariant control points that help in increasing the security in control access system. The differences between our work and that proposed in[3], is that we use as identification the five fingers considering that the distance between the thumb and the index as unique and invariant measure. However most of the works in this context [6,7,3], uses only 4 fingers or two finger widths[3], that can vary with the different status of the person. Testing of the developed methods of authentication is conducted on the basis of database which consists of 500 images of 100 persons. It is established that probability of authentication makes 98.2% (probability of error origin of the first class is 0,9%, probability of error origin of the second class is 0,9%). Our future work is to combine more than one biometric as an authentication method like voice authentication in conjunction to the palm print authentication, taking in consideration the variations of the voice in different conditions.

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