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Method of Authentication of Users of Mobile Devices

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Abstract: The study discusses the approach to the construction of biometric systems authenticate the user for access to information resources in computer systems and also a device is proposed for measuring biometric parameters of the handwritten of handwriting in the form of a many-component sensor and method data processing, biometric measurements will be designed to authenticate a user by handwriting to the handwriting in the systems of access to information resources. The applicability of the proposed approach for the construction of any access control system. The technical result is to increase the reliability of access in all systems requiring a means of identification. The technical result is to increase the reliability of access in all systems requiring a means of identification.

Key words: The analysis of biometric data, authentications of the user on hand-written handwriting, access monitoring systems, Russia, access

INTRODUCTION

Feature of the real stage of informatization of society is that the computer moved from the desktop to knees and palms, the modern notebooks, pads, communicators and mobile devices are a means of access to information resources of a global info-communication area network. Efficiency of receipt of data, usability, possibility of visualization of information promote broad use of mobile devices not only as means of information communications but also for the solution of practical office tasks and maintenance of business.

In this connection, relevant questions are direct user interaction with mobile devices, in particular the problem of user authentication of the mobile device. Computer technologies in recent years offer a large number of opportunities for use of the modern means of authentication of users, special attention is paid to dynamic biometric authentication: on voice messages, on subconscious movements of a pen in case of hand-written input, etc.

The problem of Handwritten Signature Verification (HSV) is widely described in research (Rozenberg, 2012; Fotak *et al*., 2011; Pansare and Bhatia, 2012; Sigari *et al*., 2011). For example, a review on PII protection technologies numbers general requirements for risk assessment and reasons about the ways to reach the optimal protection. Agree with the researcher, hashing and masking are not practical as well as encryption in case it is used as a primary method. The review posits that vaultless to kenization is the optimal solution which could provide analytics running as well as data security (Rozenberg, 2012).

Biometric methods provide secure solutions which are resistant against various types of attacks and are used for authentication. One of the biometric methods, handwritten signature, verifies the shape of writing, the speed and the pressure as an individual characteristic for a person. This is a personal biometric trait which cannot be completely imitated, being considered as a fundamental and constant reflection of the entire personality.

Several methods of handwritten signature verification (HSV) have been proposed in research press by now (Fotak *et al*., 2011; Sigari *et al*., 2011). In the study (Igarza *et al*., 2003), a method for HSV which is based on Hidden Markov Models (HMM) techniques is introduced. The researchers compare different topologies in order to set optimal parameters for a signature verification system. The final model included sets of interpolated and extrapolated normalized points, which corresponded to the original signature. The researchers outline that if several additional parameters such as speed, acceleration, inertia axis, etc. could be included into the model, the system would improve significantly.

Artificial Neural Networks (ANN) have also been applied to HSV thanks to its recognition power and having demonstrated good verification results. With this aim RBF and Back-propagation ANNs were used in (Fahmy, 2010; Kumar *et al*., 2013) with the classification rates 91.21 and 88.0% for the RBF and 82.66% for the Back-propagation ANN, respectively.

In the reference (Fahmy, 2010) Discrete Wavelet Transform (DWT) is used for HSV. The system has been tested on the test database, which included signatures 5 users (20 genuine and 20 skilled forgery signatures) with

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the success rate of 95%. Another application of the DWT for the HSV, introduced in the reference (Prashanth *et al*., 2012) and the following test (data base consisted of 80 signatures from 4 persons) contributed to fix optimal value of the threshold.

Thus, a large number of operations of domestic and foreign authors is devoted to a study of the matter, however many questions require the analysis and further development. In particular, require development the questions connected to a method receiving biometric measurements not all possible approaches for extraction of the informative data from biometric measurements, execution of the procedure of authentication, etc. are considered. In this study approach to creation of control systems of access on the basis of the biometric image created on dynamics of subconscious movements of the user is considered.

MATERIALS AND METHODS

Way of receiving a biometric image at construction access control systems: Handwriting recognition can be made from the text which is already written on study or reading of movements of the stylus on the surface of the special touch screen (digitizer). In all given cases for input of the hand-written text it is used "the scanned representations" that is the source text is entered in the form of graphic images from screens of pads or digitizer and then the graphic image is recognized and will be transformed to a digital code. Use of graphic images doesn't allow to execute input of confidential data.

Thus, the problem of wide use of hand-written input and recognition of the text is that the graphic image is the only way of input of the hand-written text for formation of a biometric image.

Respectively, all methods and algorithms of recognition of hand-written texts are based on the analysis and recognition of images that significantly limits possibilities of recognition and identification.

In this study is considered the approach to creation of control systems of access based on biometric measurements of the subconscious movements of the user executed by means of the special device (Rozenberg, 2012) (Fig. 1).

Difference of the offered approach to creation of the control systems based on use of hand-written input is use instead of the standard multimedia device of hand-written input (the graphical tablet) connected to port of a mouse, the specialized multi-component sensor of movements (Fotak *et al*., 2011; Lapina, 2012) sensitive to pressing any surface and allowing for n directions plane of movement of the sensor to fix measurements of pressure force on i radially located strain gage with the subsequent digitization (Fig. 1).

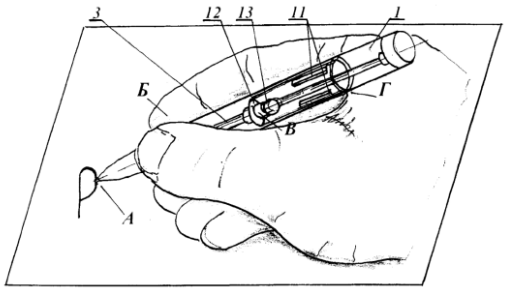

Fig. 1: Multicomponent displacement sensor, patent 2475842 (1: The sensor housing, 11:Device with a reference matrix of user dataНаПраВтеНий, 12: Dsensitive membrane,13-radial load cells pressure)

Pressure of an element of a writing node upon strain gages of radial relocation will be transformed in multi-channel (on number of strain gages) an electrical analog signal. For later processing conversion of a multi-channel analog signal to a multi-channel discrete signal is executed and quantization of the discrete counting is executed (Lapina, 2012). The diagram of the device for measurement of parameters of a moving node (Lapina, 2012) is provided on Fig. 2.

The volume of basic data, for the analysis of dynamics of writing of the hand-written text presents a trajectory of the movement of the writing knot when writing the password phrase-curves of fluctuations of the writing knot on axes coordinates $X_1(t)...X_n(t)$ and change of pressing of the writing knot a curve of pressure of P(t).

On the basis of a set of quantized discrete counting of an analog signal the matrix of quantized counting of $B_{M\times H}$ is created of $M\times N$ f_{ij} elements where f_{ij} amplitude of a quantized signal of i = 1, 2., M, j = 1, 2, ..., N (Fig. 3).

Forming of a biometric image it is, as a rule, carried out with use of linear functionalities. Usually as linear functionalities choose discrete cosine transformation of a matrix of quantized counting (Igarza *et al*., 2003), Fourier, Walsh, Haar's orthogonal functionalities (Henniger and Muller, 2009). Harmonious basic functions of transformation of Fourier are localized in frequency area and not localized in temporary, contrast are pulse basic functions of wavelet transformations which are extremely localized in a time domain therefore similar transformations are effective for the analysis of signals of final duration with strongly expressed local features in the form of short-term splashes and fluctuations.

Haar's transformation is the elementary wavelet transformation possessing the following to filter

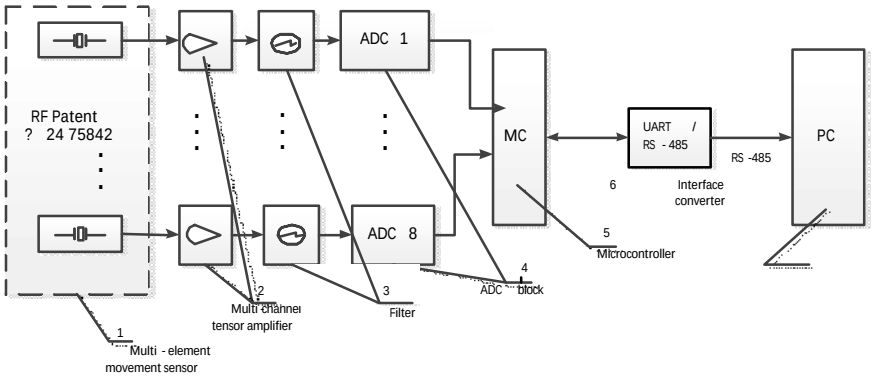

Fig. 2: System for pressure estimation when the movement sensor moves in n directions RF Patent No. 2475699

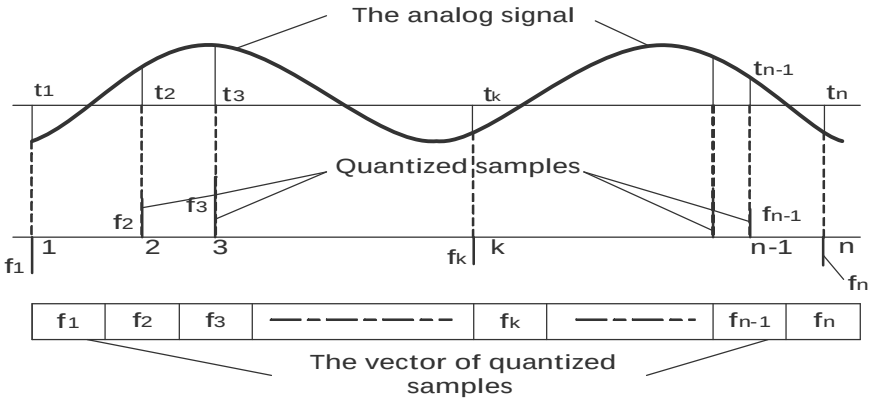

Fig. 3: The formation of the matrix of original dimensions

subranges of low level which don't contain essential features of a signal therefore they can be rejected safely. It gives good compression with partial loss of information which won't affect quality of the restored image.

In this study for the analysis of a multi-component signal of the sensor of movements Haar (Lapina, 2012) transformation which allows to execute approximation initial splashes and fluctuations initial d signal limited number of the components of a number of Haar located in the corresponding part of an interval (O,T) is considered. In the case considered in study two-dimensional discrete transformation of Haar includes processing of a matrix of N×N of discrete values of measurements of the multi-component sensor of movements.

Operations at first are carried out every line of a matrix and then the same operation is carried out with each column of result. We will give an example of performance of transformation of Haar for a matrix 4×4 (Eq. 1):

$$P = \begin{pmatrix} 18 & 14 & 12 & 4 \\ 10 & 6 & 8 & 8 \\ 16 & 4 & 8 & 0 \\ 12 & 0 & 4 & 4 \end{pmatrix} \quad (1)$$

The first step of two-dimensional discrete transformation of Haar consists of one-dimensional transformation of each row which is carried out by multiplication of matrixes of P and W (Eq. 2). Matrix W orthonormal function of Haar of the fourth about (Frias-Martinez *et al*., 2006):

$$PW = \begin{pmatrix} 18 & 14 & 12 & 4 \\ 10 & 6 & 8 & 8 \\ 16 & 4 & 8 & 0 \\ 12 & 0 & 4 & 4 \end{pmatrix} \times \frac{1}{4} \times \begin{pmatrix} 1 & 1 & 2 & 0 \\ 1 & 1 & -2 & 0 \\ 1 & -1 & 0 & 2 \\ 1 & -1 & 0 & -2 \end{pmatrix} = \begin{pmatrix} 12 & 4 & 2 & 4 \\ 8 & 0 & 2 & 0 \\ 7 & 3 & 6 & 4 \\ 5 & 1 & 6 & 0 \end{pmatrix} \quad (2)$$

The following step consists in performance of one-dimensional transformation of each column. For this purpose the matrix of transformation of columns is transposed, then multiplied by a reformative matrix then the result is again transposed. In the same way it is possible to transpose a reformative matrix and to increase it by a matrix of the transformed columns (Eq. 3):

$$T = \left(\left(PW \right)^T \times W \right)^T = W^T \times P \times W \quad (3)$$

the sign $()^T$ means transposing. Thus, two-dimensional discrete transformation of an initial matrix of P will be (Eq. 4):

$$T = W^T \times PW = \frac{1}{4} \times \begin{pmatrix} 18 & 14 & 12 & 4 \\ 10 & 6 & 8 & 8 \\ 16 & 4 & 8 & 0 \\ 12 & 0 & 4 & 4 \end{pmatrix} \times \begin{pmatrix} 1 & 1 & 2 & 0 \\ 1 & 1 & -2 & 0 \\ 1 & -1 & 0 & 2 \\ 1 & -1 & 0 & -2 \end{pmatrix} = \begin{pmatrix} 12 & 4 & 2 & 4 \\ 8 & 0 & 2 & 0 \\ 7 & 3 & 6 & 4 \\ 5 & 1 & 6 & 0 \end{pmatrix} \quad (4)$$

The transformed matrix of T contains average value of all elements of an initial matrix in the left top corner (8) and other elements correspond to differences. The elements which are spaced far apart from the left top corner correspond to the level of more exact specification, that is more high-frequency elementary waves. The received matrix of coefficients of two-dimensional discrete transform of Haar is used further as an identification image in case of authentication (Lapina, 2010, 2012).

Use of expansion of a signal on n of the directions of relocation of the device for measurement of parameters of a moving node allows to make the analysis of each fragment of expansion of a signal, vector of identification parameters V that simplifies the task of a marking and the analysis of the initial identification image.

RESULTS AND DISCUSSION

Authentication of the user on the basis of closeness measurement image to a biometric standard the Hamming measure: After the biometric image is created, implementation of procedures of authentication of the registered user is possible. One of simple decisive rules is use of a measure of Hamming for bit representation of a vector of $V = (v_1, v_2, ..., v_k)$.

Let the system in case of identification realize measurement of a vector of $V = (v_1, v_2, ..., v_k)$ consisting of k of biometric parameters.

Let at a stage of registration (training) the authorized user showed N signatures and respectively, we have N implementations of vectors of V_i.

The user allowed in system rather seldom is mistaken and, respectively, Hamming's measure for him is small. In attempts to be authenticated the user who is illegally logging in mistakes are much more frequent. It allows to make the decision on the admission of the checked face in computerized system.

Having analysed the available realization of vectors of biometric parameters, it is possible to find a characteristic interval of change of each concrete parameter $[\min(v_j), \max(v_j)]$. If now at contact of the v_j parameter in an interval $[\min(v_j), \max(v_j)]$ to appropriate $e_j = 0$ and falling out of v_j from an interval $[\min(v_j), \max(v_j)]$ to appropriate $e_j = 1$, then we will receive Hamming's vector. For the registered user this vector has to consist practically of one zero. For the unregistered user showing other biometric parameters, Hamming's vector will have a large number of discrepancies, a large number of units.

For the considered case the biometric standard recorded when training are values of minima and maxima of the measured parameters. Then, absolute value of distance of Hamming, E_x to a biometric standard should be defined as total number of falling out of measurements for intervals of admissible values of a biometric standard. Hamming's distance, E_x is always positive and can change from 0-k (where k is a number of controlled biometric parameters).

CONCLUSION

For obtaining biometric data in access control systems on hand-written handwriting it is offered to use the specialized device of measurement of parameters of the writing knot forming an identification matrix on the basis of the measurements which are carried out by the multi-component sensor of movements.

The technique of forming of a biometric image on the basis of dynamic characteristics of signals of the signature by means of Haar's transformation is offered. Unlike known such approach doesn't require considerable computing costs and allows to provide forming of high-informative dynamic signs. Authentication of the user is carried out by measurement of proximity of an image to a biometric standard by Hamming's measure.

The method of creation of control systems of access on the basis of separation of significant personal dynamic parameters of the signature for identification from the basic data provided by a multi-component signal is offered.

Results of operation can be applied during creation of systems of biometric authentication of users of mobile devices, in tasks of automatic handwriting recognition Besides the offered approach can be used in case of creation of any control systems of access and also for obtaining information about psycho-physiological a status of the person.

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