Systems for Personal Identification using Methods of Signature and Handwriting Verification

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ABSTRACT

The problem of automatic signature and handwritten text verification is considered. The working out of these applications is indicated to have to fulfil in common with criminalists and basing on well approved methods. Some results are considered on performance of the Belarussian-Polish project on creating the Automatic Signature and Handwriting Personal Identification Systems (ASHPIS). Some ways to increase the efficiency and improve the characteristics of the applications.

INDEX TERMS

Signature authenticity (verification), security, handwriting verification, Optic Character Recognition (OCR).

1. INTRODUCTION

The instability of economics in CIS and some Eastern European countries causes the sharp growth of crimes such as forgery of documents. It was obvious that it is impossible to control if only major flows of documents without new automatic systems. The crimes in this sphere stimulates works on creating the ASHPIS. It should be noted that these systems are oriented onto social infrastructures of the former Soviet Union and socialists countries.

The most number of crimes is registrated in social (payments of pensions, allowances, compensations and others) and financial areas. The imperfection of these structures and resourcefullness, skill of criminals, allow to commit financial crimes in a large scale. As an example, it should be said that the overwhelming number of payments and remittance by written order are made basing only signature and passport. Neither one sepaprately or together is not guarantee of authenticity of clients what is used by crimes. Numerous tests and experiments have indicated the practically full unprotectiveness of financial documents (the talk is about CIS). However at present there are many serious financial crimes in bank information systems and world telecommunications where computer security systems are used. It spears well for working out complex security systems using non-traditional approaches equally with classical methods.

There are many ways to solve these problems, however all ones assume the principal exchanges in social and financial spheres. One of links of new approaches to person identification is the signature and handwriting verification. It should be noted that the solution of this problem is of independant importance since the results may be widely used in the brackets of existing infra-structures of CIS and Eastern European states. Furthermore, there are criminalists' problems. Following to estimating of criminalists of some Central and Western European countries, the number of documents examinations on signature has essentially increased during last years. Intensity of CIS criminalists' work does not estimated, but it may say about sharp growth of number of examinations. Unfortunately, the level of automatization of their work is very low. For example, to examine a signature or handwriting it is required several hours. Owing to the causes enumerated the project under consideration assumes a working out ASHPIS and integrating them into existing ones.

Other handwritten signature verification systems are known too. For instance, by replacing passwords with signatures as a means of securing access to machines and networks. Typical hardware configurations for these purposes include pen computers or digitizers attached to a desk-or laptop computer. These applications provide safe and simple security and minimize the business risk instead of paper.

Many firms of USA, Germany, UK, Russia work on the trend, for example, in UK Peripheral Vision extend its support for its Pen Op software range to encompass Microsoft Windows for Pen Computing V.1.0 and V.3.1 and IBM's OS/2 V.2.1 and Pen OS/2 V.1.0.

2. THE CRUX OF THE PROBLEMS

The problems of personal identification through signature and handwritten concern the classical tasks of criminalistics, such as, for example, the identification of finger-prints. There are many criminalistic methods to solve them. These methods are inter-disciplinary since they use achievements, modes and mathematical tools from various branches of science and engineering. Algorithmisation and realisation of the methods has resulted in to some new (qualitative and quantitive) changes in potentialities, estimates, characteristics and areas of applying these systems. This process cannot do without some paradoxes. For example, the influence of information technologies onto criminalistics methods achieves such level when criminalists refuse to identify themself methods, i.e. do not sertificate a system, although one allows to receive results no worse than when applying using modes generally used. The criminalists' conservatism may be fully explained and it is of certain positive importance. On the other hand it is necessary to clearly conceive the areas of applying the ASHPIS. They may be classified as situations permitting the receiving an additional information about a person, and situations excluding such opportunitiy. For example, when drawing up financial documents by a client, he can be required to make the additional signature or manuscript data to analyze his handwriting. However a criminalist has not often such opportunity when dealing with suspect documents and he has to bear the responsibility for the decision.

Therefore the systems' importance and functionsare changed depending of use area. It means that only a class of ASHPIS meets real needs.

To solve identification problem considered it is necessary to be three principal components defining all the systems' functions and characteristics (Fig.1): (a) unit of input of signature and handwritten text, (b) signatures and handwritten database,(c)verification module.

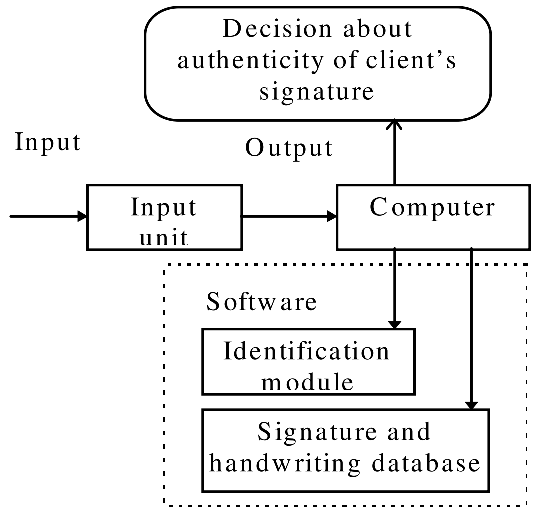

Fig.1.

The input unit may be constructed basing a scanner or scanning digitizer. A scanner allows to input only two-dimensional graphical objects, i.e. signature and handwritten text from a paper, and a scanning digitizer permits to receive an additional information: characteristics of a pressure when signing and writting, and also a manner of holding a writting instrument.

The identification problem may be solved only if there is a base of signatures and handwritten text features belong to a real person. The creating of a database is not a trivial problem. It is previously reguired to choose special features from the information received, to optimize and compress its. Identification algorithms are essentially differed depending of assumed data. The most complex is a case when it is necessary to process an information from two connected objects (two end-points of a writing instrument) of three-dimentional coordinate space. The characteristics may be devided into next classes: frecuency-related, graphical and geometrical, dynamic, pressure-related. The identification algorithms are based on methods of mathematical statistics, analytical geometry and decision modes. This is one of most complex components of the system.

Some approaches to solve these problems are considered, for example, in Proceedings of the International Conference on Document Analysis and Recognition.

3. CHARACTERISTICS OF SIGNATURE AND HANDWRITING PERSONAL IDENTIFICATION SYSTEMS

The main and most significant characteristics of ASHPIS is *the authenticity of personal identification*. This estimation may be expressed as probability or percents. However, here there are many practical questions, in particular, how to influence on this estimation, how it may be calculated and others.

As a rule all the systems must work in the conditions of incompleted information about object. For example, it is insufficient one signature inputed through scanner from paper to identify a person when using any well-known methods. More exactly, there is sufficiently great class of graphical objects for which it is impossible to establish the differences between a truth and forged signature with the necessity authenticity. However, in practice a man needs to decide for the situation given. For this the additional information is used, for example, special codes, identity cards and others. Thus, one of ways to improve the authenticity of person identification is the using an additional information about an object.

The task of one of stages of the Belarussian-Polish project is to create the ASHPIS using signatures on financial documents scanned and using an additional information such as handwritten text on these documents (data, month, name, sum, name of financial organisation and others) (Fig.2).

The personal identification authenticity may be essentially improved owing to pass from two-dimentional coordinate space (graphical objects of surface) to three-dimensional one. It means the substitution of a digitizer for a scanner that allows to analize a “manner” of performing a signature by a pressure (Fig.3). An additional information may be received in the form of trajectory of writting instrument too. Other characteristics of the System is *a volume of clients’ signatures and handwritings database*. These characteristics may be varied from several thousand (small commercial bank, social sphere enterprises, local police office) to hundreds of thousands.

Finally, the Systemis characterized by *decision time*. It may be varied from a fraction of a second to tens of minutes. For example, the identification of a clientin a bank has to occupy several seconds, and when making an examination of documents it may be used the systems with speed of tens of minutes.

Other characteristics are derivatives from three main ones considered. For example, time of searching some signatures in database, a probability of need of an additional information (a client ought once more to sign document) etc.

It should be noted that three characteristics enumerated (authenticity of signature personal identification, volume of clients database and decision time) are functionally connected between themself. It means that a change of one of them results in changes of others. For example, improving the authenticity of personal identification in a number of causes leads to exponential growth of decision time. This effect particulary is compensated by optimizing the work of the system components, increasing the computer’s power and using network technologies, for enstance, powerful server.

4. PROJECT ON CREATING THE SIGNATURE AND HANDWRITING PERSONAL IDENTIFICATION SYSTEMS

The present project consists of 7 stages, a number of them are parallely executed. Fig.4 gives the full representation about project stages. The class A is formed by systems where input of information is made through a scanner, and in the class B a scanning digitizer is used. Each stage is completed by creating one of versions of the System fit for exploitation. For example, the architecture of third version of the system is shown in Fig.5. The version has the following functions: - signature verification, - handwritten text verification, - input of documents from paper through a scanner.

Fourth version of the System (Fig.6) is characterized by input of information through a scanning digitizer. This system intends for working in touch with a client and provides the high authenticity of personal identification.

The project provides integration of all the versions of the system with OCR. This is the first step on integrating the ASHPIS into existing Document Management ones.

The fragments of working the experimental Systems are considered in Appendix of the paper: (a) Automatic System for Personal Identification MANUSCRIPT 1.24, (b) Personal Identification System SIGN INSPECTOR V.1.15, (c) OCR-system ADRES 1.2.

The MANUSCRIPT 1.2.4 is intended for handwriting verfiication when input of a text is executed through a scanner. Its functioning is represented by 5 steps: Step 1 - loading data, Step 2 - processing handwritten text: lines detection, lines approximation, precise lines detection and others, Step 3 - processing of handwritten text: connected groups detection, Step 4 - processing of handwritten text: processing connected groups, Step 5 - processing handwritten text: processing lines. After Step 5 it is come to a decision basing the estimations and characteristics computed.

The SIGN INSPECTOR V.1.15 is intended to verify signature putting through a scanner. The signature verification process is represented by 6 steps: Step 1 - loading data (input data through a scanner and choosing a person's signature from database, Step 2 - computing parameters (motion co-ordination), Step 3 - computing parameters (dynamics measures), Step 4 - computing parameters (signature biomechanics), Step 5 - computing parameters (orientation measures), Step 6 - decision about authenticity.

The ADRES 1.2 allows to recognize Russian, English, Polish text printed on financial documents. The Application can read text typed, photoset, printed by laser or LQ, NLQ or 9-pin matrix printer, faxed. A notion about principles its design may be received from several steps of its work: Step 1a - loading data from file or Step 1b - loading data from a scanner (scanning and preprocessing data), Step 2 - processing and receiving results of recognition, Step 3a - studying the system to recognize new characters (making etalon), Step 3b - studying the system to recognize new characters (control the studying by operator).

5. PROBLEMS

Practically all the ASHPIS ought to work when an information about object is insufficient. We must understand as insufficient information also the fact that we cannot evoke the necessary data from them flow. For enstance, it is known that man's signature is changed even during a day and depends on his feeling, mood, writting instrument, situation, etc. Probably, it is impossible to determine what factors affect signature and handwriting to the greatest degree, since this influence has an individual, groupped, strongly correlated character. It is obviously that when automatizing the identification process there is no going on the way of personal psycho-analysis, since our knowledge in this area are very scant. It is expedient to find the modes to receive an additional information, say finger-prints, voice, phisical parameters, individual code and others. However no always an opportunity offers to identify finger-prints, for example, because of ethic reasons. Then it should be "supported" the ASHPIS by using a voice spectrum analysis. However, the existing systems no always allow to identify voice 100 % guaranteed.

Thus, in most practical tasks of person identification basing modern information technologies it is to be solved the problem of evoking of an additional information about object in the purpose of improving identification authenticity. As a rule, researchers and designers of these systems come to *complex person identification Applications* performing an analysis of various individual parameters and characteristics. On this stage it need to solve some new problems, in particular, optimization questions concerning estimates of identification authenticity. However, when working out commercial Systems these problems may be often simplified.

It should be noted that in most cases the identification problem ought to solved during limited time (seconds, as a rule). It is other optimization question. But the difficulties enumerated has not the principal character and has a decision.

CONCLUSION

The need of creating ASHPIS is conditioned by growth of number of crimes in social and financial spheres (the talk is about CIS). These systems are of original significance, i.e. can perform functions of protective filter in financial resources movement. At the same time they should be considered as a component of complex security Application.

The fulfilled Belarussian-Polish project on creating the ASHPIS is called for deciding a number of problems in various spheres (banking, financial, social, legal). This project is based on criminalists' experience, graphology and handwriting science methods and uses modern achievements of information technologies. Project is on the stage of experimental researches whose results are highly optimistic.

The other side of the project is a help in training specialists for economic, financial and banking activity. There is the course "Banking Information Systems and Telecommunications" in Belarussian State Economic University (Republic of Belarus) and Institute of Computer Science and Engineering, Technical University of Szczecin (Poland). One of its chapters is devoted to questions of person identification, including signature and handwriting verification. Future economists, bankiers, finansists learn modern methods and means of providing the security of financial flows, aspects of their applications using examples of training bank. Our purpose is that future financiers and bankiers should understand the risk of using the modern banking IT and telecommunications, absence of absolutely reliable methods and means of security, the necessity of developing this sphere.

The identification problems (for printed and manuscript characters) are enough learned and have the progress. This is connected first of all with applying the neural networks. In the brackets of Belarussian-Polish project a number of signature and handwriting identification experiments have executed on neural networks. On our view the future of systems of this type is connected with the neural networks and Genetic Algorithms. Some optimistic results are also received on using Hidden Markov Models for signature verification.

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