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Pattern Recognition in Biological Systems of Personality Authentication

There are considered some conceptual subjects of construction of mathematical apparatus for pattern recognition in the biological systems of personality authentication.

Setting up a problem

One of major directions regarding increasing safety of information, processed and kept on objects of informative activity is development of the effective automated systems of checking and access control systems on these objects [1]. Efficiency of the indicated systems can be increased on the basis of improvement of the automated biometrical systems of recognition of personality as element of artificial intellect.

Under the «biometrical system of recognition of personality» according to [1] is understood the system, providing recognition of man (personality) on the basis of authentication and analysis of the psychophysical state of personality, which is especially actually at the decision of task of control and access to the objects of informative activity with the high degree of secrecy. Both physical objects (apartment, building, territory) and informative-telecommunication systems of the different functional purpose can act as an object of informative activity.

The systems of recognition of personality are conventionally subdivided into simple, using one feature, and complex, carrying out authentication of personality on combination of features.

The distinctive mark of the complex systems of authentication of personality is a necessity of realization of processes of measuring and treatment of features, having, as a rule, different nature, and, therefore, different scales of measuring.

The system of recognition of personality makes an analysis of biometrical, behavioural and medical informative features presented by identified personality and statistical and dynamic images obtained on their basis; description of parameters, characterizing presented features (images); search of informative parameters, sufficient for correct recognition; description of images in space of transformable informative parameters, and also comparison of selected informative parameters with those kept in a database and taking decision on referring personality to the certain class (with some error, errors of the first and second kind). The basic task of the recognition of personality is a decision of task of classification.

Construction of description of the personality image on combination of features is a complicated task. It is explained by complication of providing necessary terms during measuring of features, by instability of parameters of personality, to strong influence of external factors both on personality and on the measured features.

Presently the most widespread approach of construction of this class of the systems is their presentation as a combination of subsystems, each of which is directed on measuring, processing and parametrization of one concrete feature. A decision-making on combination of features is made on the basis of statistical estimations of the errors levels of the developed biometrical system, obtained on the stage of classification of personality on each of identifying features. The values of errors depend on the fact how effectively the basic structural stages are realized in the system of recognition, namely: high-quality preliminary processing of the measured features, optimum correlation of amount of the analyzed parameters and their self-descriptiveness, applied decision rule. Decision of similar task using electrocardiogram , voice and iris of eye as features are considered in [1].

As practice showed, for complex biometrical system of recognition of personality, built on the principle considered higher, characterized by the following: necessity of using unique programming and hardware facilities on the stages of measuring, processing, parametrization of each feature; uniqueness of apparatus for depiction of the personality images; uniqueness of the knowledge base for description of images, algorithms of classification and authentication of personality. That is why, presently, one of the actual directions of increasing efficiency of the biometrical systems of recognition the personality of this class is development of new approaches to description of images and apparatus of their authentication.

The purpose of the article is presentation of mathematical apparatus for creation algorithms of pattern recognition, based on conception of decision-making in state space with using knowledge about the structure of this space.

Description of basic material

The fundamental concept of the offered apparatus is a concept “pattern”, under which are understood description of object, situation or phenomenon with the help of the preset system of features.

Recognition represents process of decision-making on the basis of entering information about recognizable pattern, knowledge about the structure of space of descriptions and procedural knowledge of finding a co-ordinate decision in this space. This process has a polycyclic nature and will realize procedure of advancement and verification of hypotheses.

The fig. 1 shows the chart of the intellectual complex system of personality recognition built on the basis of principles offered by authors.

We will consider the main provisions of the conception of construction the complex biometric systems of the personality recognition offered by authors.

Description of patterns

The pattern is described with the help of the great number of features À. Connection between the pair of features $a,b \in$ A, described by the followings binary relations:

a) relation of equivalence *(a-b)*:

$$\rho = \{(a,b) : z(a) = z(b)\}; \quad (1)$$

b) relation of strict preference *(a,b)*:

$$\rho = \{(a,b) : z(a) > z(b)\}, \quad (2)$$

where *z(i)* is a value of feature *of i* in the preset scale.

The description of pattern obtained in such a way represents linear quasiorder and has the appearance of line, reflecting organization of features *A*.

The relation of equivalence is generated by breaking up of great number A as follows: a and $b \in A$ are referred to one class, if $(\alpha, b) \subset \rho$. Such description of pattern can be presented as follows :

$$R = \{k1, by\ 2, ..., to\ m\}, \tag{3}$$

$$\bigcup_{i=1}^{m} k_i = A, \tag{4}$$

where k_i is a class of breaking up of A, $k_i \cap k_j = \varnothing$, $i \neq j$.

The classes of breaking up of R can be numbered so, that relation ρ coincides with the relation of succession. Thus, we obtain the well-organized breaking up.

In the case when in breaking up of R there are no equivalent elements, i.e. all classes of breaking up are one-element, then relation ρ forms a linear order.

Great numbers of all relations of linear quasiorder on A from the geometrical point of view form the space of linear quasiorders (SLQ), great numbers of linear orders are space of strict order (SSO).

Ranging of elements of great number A we will interpret as points of these spaces.

We will designate through QLM space of linear quasiorders with carrier A, $\|A\| = M$, where M is an amount of objects in a great number A.

Let $R = \{R_1, R_2, ..., R_m\}$ and $P = \{P_1, P_2, ..., P_m\}$ are two breaking up of great number of À. Matrices $r = \|r_{i,j}\|^{M_{i,j}=1}$, $\rho = \|\rho_{i,j}\|^{M_{i,j}=1}$ are matrices of connection of elements in breaking up of R and P respectively.

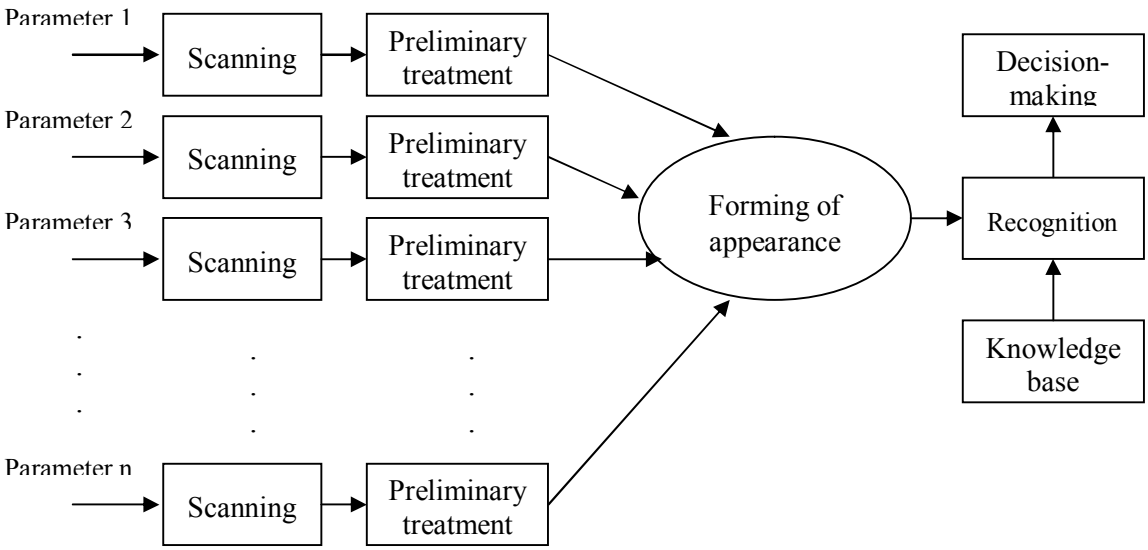

Figure 1 – A chart of the intellectual complex system of personality recognition

Let

$$e_{i,j} = \begin{cases} 1, \text{if } (i,j) \in \rho \\ 1, \text{if } (i,j) \in \tilde{\rho} \\ 0, \text{if } (i,j) \notin \rho \end{cases} \tag{5}$$

Then distance of $d_x\ (R, P)$ between the points of R and P is determined on a formula:

$$d_x(R,P) = \sum_{i,j=1}^{M} \left| r_{i,j} - p_{i,j} \right|. \tag{6}$$

Consequently, *dx(R,P)* is the amount of the bitwise non-coincidence of elements of matrices *r* and p.

Function of selection

By the function of selection of the co-ordinate point in SLQ will call three:

$$(QL,\ D \subseteq QD,\ C{:}D \to QL), \tag{7}$$

where QL is an initial great number of possible descriptions of recognizable images $QL \in QA$,

D is some part of great number of QD of all subsets of multitude QL, $C{:}D \to QL$ is such relation, which for any subset of G from QL, $D(G) \to T$, T is a co-ordinate point.

As a co-ordinate point of multitude the point T is taken, for which is adopted the just condition:

$$\bigcap_{i=1}^{n} T_i \subset T \subset \bigcup_{i=1}^{n} T_i \tag{8}$$

Using apparatus of geometrical approach to finding group decisions, there were developed standard procedures of finding co-ordinate point in SLQ, which made basis of multitude M of grammar W and procedural knowledge of the biometrical system of personality recognition.

Researches of properties of different functions of selection with taking into account of admissible types of producing multitude G showed that the functions of selection for points $G \subseteq X_Y^{S-1}$ met condition of inheritance, that is

$$|G| > 1,\ G' \subseteq G,\ |W'| > 1,\ R \in c(G) \to R \in c(G') \tag{9}$$

and to the condition of omission:

$$|G| > 1,\ G' \subseteq G,\ |G'| > 1,\ \forall G'{:}\, c(G) \to R,\ c(G') \subseteq c(G). \tag{10}$$

If $LG \subseteq X_{R_1}^{S} \cap X_{R_1}^{S}$, $|LG| > 1$, the class of functions of selection for LG possesses with property of co-ordination:

$$\forall G,\ z \subseteq LG,\ c(G) \cap c(z) \subseteq c(G \cup z) \tag{11}$$

therefore, the task of search of a co-ordinate decision in SLQ on the preset presentation of G in SLQ comes to selection and using procedures of finding point, meeting condition (8), on the basis of procedural knowledge of the system.

Because the process of searching of a co-ordinate decision in SLQ does not depend on concrete data domain (DD), then for recognition of the preset multitude of objects the adjustment of system for concrete DD is needed. In this case the relevant subspace is selected in SLQ which is used as space of search of decisions for preset DD. In this space the classes $Q = \{Q_1, Q_2, \ldots Q_m\}$ are selected concering descriptions of recognizable objects, standard descriptions of these objects are formed, which are considered as centers of relevant classes, the maximum and minimum points of each class are determined.

The maximum point of class *of* Q_l, $Q_l = \{Q_1, Q_2, \ldots Q_l\}$, is the point $R_l^M \in Q_l$, for which justly $Pot\ R_l^M \geq Pot\ R_i$, $i = \overline{1,\ t}$, and minimum is a point of $R_l^m \in Q_l$, $Pot\ R_l^m \leq Pot\ R_i$, $i = \overline{1,\ t}$. The distance from the center of class of R_1 to R_l^M is called the distance to the high boundary of class of Q_l, distance from R_l *to* R_l^m – is the distance to the low boundary of class of Qi.

The combination of classes of objects descriptions forms the space model of searching decisions for concrete DD. Knowledge about the structure of SLQ allows to use only three characteristics in a database system during description of class: description of the class center and value of distances to the upper and lower of its boundaries.

Conclusion

The distinctive feature of the offered method consists in introducing "universal", in certain sense, space of pattern descriptions for pattern classification on minimum of distance. There are developed standard procedures of decision-making on the basis of input data and knowledge about space of pattern description.

Basic provisions of the offered approach will be considered and detailed in next papers of authors.

Literature

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