Visual Image Biometric Identification in Secure Urban Computing

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Abstract. In this publication will be proposed a new technique of personal identification based on non-standard biometric patterns in the form of selected medical visualization. The proposed solutions will be illustrated on the example of using intelligent CPIAIS cognitive information systems for extraction an unique personal feature vector which next will be used for personal identity analysis. Such procedure will allow to support the identification processes based on several types of biometrics patterns, as well as using feature vector in cryptographic procedures. While image analysis a cognitive procedures will be based on hand layouts parameters, evaluated for particular persons during medical examination.

Keywords: cryptography, CPIAIS systems (Cognitive Personal Identification & Authentication Information Systems), semantic analysis, personal identification processes.

1 Introduction

A new techniques of personal authentication and identification based on non-standard biometric patterns in the form of selected medical visualization was proposed for a new class of cognitive systems. The essence of cognitive systems consists in the semantic analysis of images being interpreted, and particularly of medical images portraying lesions, pathologies of different organs [4-12]. Cognitive systems for analysis medical images for identification and personalization processes represent a special class of CPIAIS systems (Cognitive Personal Identification & Authentication Information Systems). This class of cognitive systems can be used to semantically analyse pathologies of human organs and personalisation and identification analyses (Fig. 1).

CPIAIS systems carry out personal verification and identification processes with the addition of medical image analysis and hand bones and heart arteries lesion detection.

Semantic analysis is carried out in systems founded on cognitive resonance [9, 11] which identifies the compliance between the set of expectations generated by the system (based on the expert's knowledge) of the analysed data set and the knowledge collected in the system, which knowledge forms the basis for executing the comparative analysis (Fig.2.).

T.-h. Kim et al. (Eds.): MulGraB/BSBT/IUrC 2012, CCIS 353, pp. 374–380, 2012.

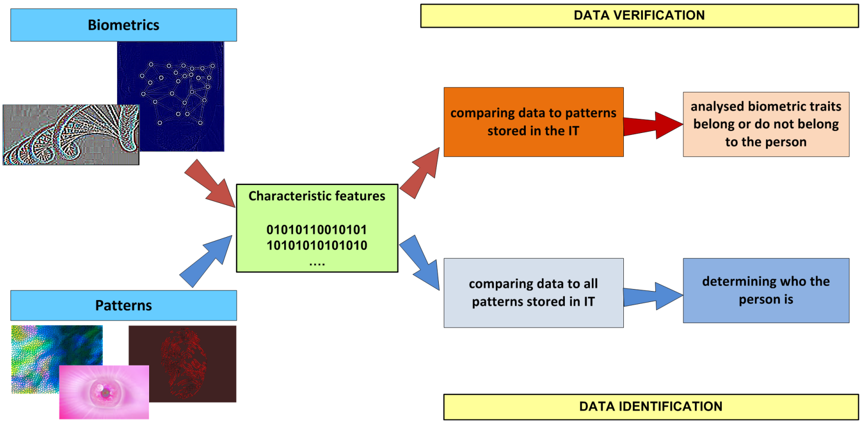

Fig. 1. Personal verification and identification processes

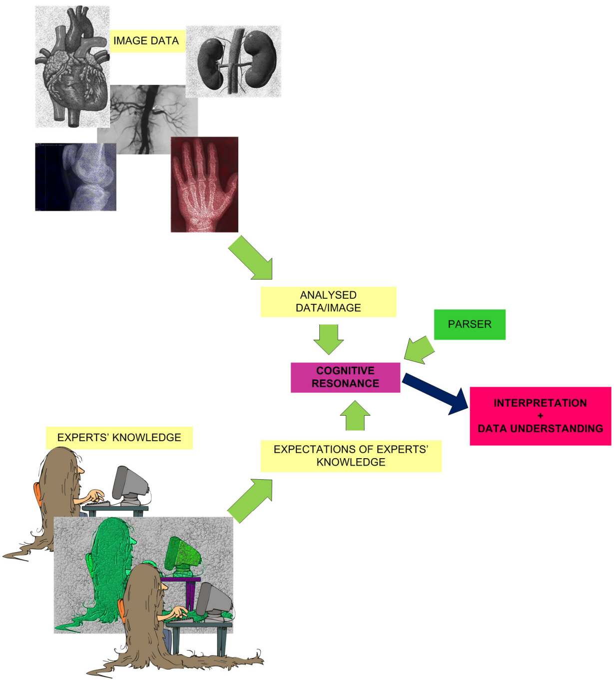

Fig. 2. Cognitive resonance in processes of interpretation and data understanding

2 Biometrics Features in Identification Process

Systems that semantically analyse medical images are essentially based on the use of linguistic formalisms grammar – can be a graph, a tree or a sequential grammar.

Anatomical features play an important role in personal analysis processes. The former are subjected to complex analysis processes which are to produce an unambiguous identification of the person whose anatomical features were analysed. The most widespread types of biometric analyses include analyses of the face, hand and voice. In the analysis of characteristic features of the face, it is important to describe and interpret parameters that can help describe a human face. These parameters are presented in the set P_f defined as follows [8]:

$$P_f = \{h_f, h_{fh}, h_n, h_{el}, h_{er}, d_{ee}, d_{el}, d_{eer}, w_m, w_n\}$$

where:

h_f – denotes the height face,
h_{fh} –denotes the forehead height,
h_n – is the height nose,
h_{el} – is the height of the left eye,
h_{er} – is the height of the right eye,
d_{ee} – denotes the distance between inter corners of the eye,
d_{el} – denotes the distance between outer corners of the eye,
d_{eer} – denotes the distance between external ends of the ears,
w_m – is the width mouth,
w_n – is the width nose.

The proposed P_f set for analysing personal features of human face has also been used to propose a formal description of the analysis of others biometric features. These features, with the added elements of the semantic data analysis, make an extended identification analysis possible. A formal solution based on defining a set of biometric characteristic features of the hand is proposed for analysing the biometric features of hand bones [8, 11]:

$$BL_h = \{th_{ij}, l_{ij}, s_{ij\text{-}ij}, th_{mi}, l_{mi}, s_n, p_i, o_j\}$$

where:

th_{ij} – denotes the thickness of the bones of the *ith* finger and the *jth* phalanx $i = \{I, II, III, IV, V\}$, $j = \{1, 2, 3\}$,
l_{ij} – denotes the length of the bones of the *ith* finger and the *jth* phalanx,
$s_{ij\text{-}ij}$ – is the size of areas between individual hand bones,
th_{mi} – is the thickness of the *ith* metacarpus bone,
l_{mi} – is the length of the *ith* metacarpus bone,
s_n – is the size of wrist bones,
p_i – denotes the print of the *ith* finger of the hand (from one to five),
o_j – is the shape of one of the three biometric prints of the palm.

The BL_h set (Fig. 3.) defines the biometric features and shapes of handprints as well as the shape of fingerprints, which make it possible to conduct a biometric analysis. Data on biometric features stored in the CPIAIS system supports personal identification and personal verification.

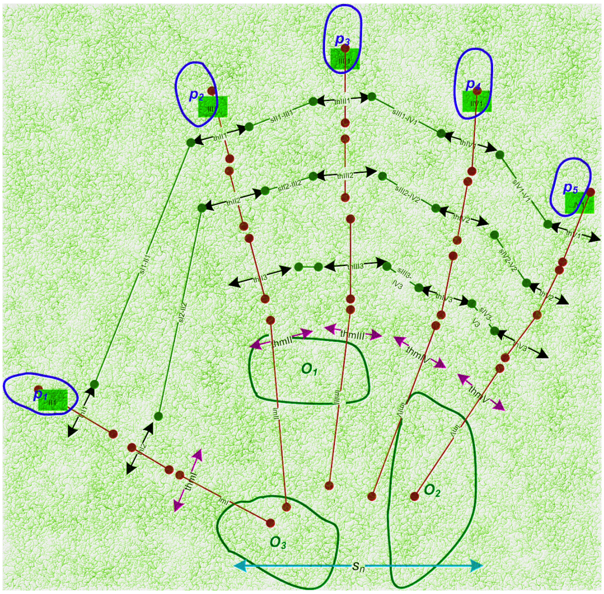

Fig. 3. Elements of the set BL_h

In biometrics analysis also it's possible to analyse medical 3D images portraying lesions in large heart vessels – coronary arteries [12]. Images of this type are acquired, inter alia, in heart disease diagnostics used to assess the lesions of the cardiac muscle and also of coronary vessels.

3D medical image data is analysed in cognitive data analysis systems on the basis of defined linguistic formalisms. In the case of analysing lesions found in coronary vessels, context-free graph grammars have been used to semantically analyse the lesions observed – G_R for the right coronary artery and the R_L for the left coronary artery [12]. Such work was aimed at proposing grammar formalisms powerful enough for analysing 3D images of coronary arteries and vessels [12]. Images of arteries, just like other multi-dimensional images showing lesions in human organs, can be subjected to a semantic analysis due to the diversity of lesions occurring. The most frequent lesions of large vessels include persistent Botall's arterial duct, trilogy, tetralogy and pentalogy of Fallot, pulmonary artery stenosis (a congenital defect), coronary artery sclerosis, congenital as well as acquired heart defects contributing to changes (or lesions) in the structure of coronary arteries.

In the data analysis process [1-3, 11, 13], the identification of the lesion occurring, its location, size and the frequency of its occurrence makes it possible to determine the significance and the impact of the analysed lesion on the subsequent diagnostic and treatment process.

3 DNA Cryptography in CPIAIS Systems

CPIAIS systems enhanced with DNA cryptography and used to generate keys based on DNA codes and genetic information can be combined with biometric features described by the BLh set. The nucleotide polymer (DNA) is made up of purine bases are bonded in pairs:

A-T, G-C, T-A, C-G

(Adenine-Thymine, Guanine-Cytosine, Thymine-Adenine, Cytosine-Guanine)

The bonding between purine and pyrimidine basses allows the DNA code to be written in an unanimous form, and the DNA code itself can be used for biometric analyses. The encoded DNA information forms the basis of cryptographic, identification and verification analyses.

This bonding has been adopted for defining a set which can for be used for executing the biometric, identification and verification analysis:

$$GEN\text{-}BL_h\text{-}P_f\text{-}CA(G_R, G_L) = \{\text{DNA CODE (A-T G-C T-A C-G)}, th_{ij}, l_{ij}, s_{ij\text{-}ij}, th_{mi}, l_{mi}, s_n, p_i, o_j, h_f, h_{fh}, h_n, h_{el}, h_{er}, d_{ee}, d_{el}, d_{eer}, w_m, w_n, G_R, G_L\}$$

The $GEN\text{-}BL_h\text{-}P_f\text{-}CA(G_R, G_L)$ set with the coded form of genetic information takes the following form:

$$GEN(\text{CODE})\text{-}BL_h\text{-}P_f\text{-}CA(G_R, G_L) = \{010110011000010100, th_{ij}, l_{ij}, s_{ij\text{-}ij}, th_{mi}, l_{mi}, s_n, p_i, o_j, h_f, h_{fh}, h_n, h_{el}, h_{er}, d_{ee}, d_{el}, d_{eer}, w_m, w_n, G_R, G_L\}$$

As a result of DNA information coding, the personal identification and the cognitive analysis carried out by CPIAIS systems, the feature vectors assigned to a given person in biometric data analysis systems can contain information about (Fig. 4):

- the DNA code,
- individual (physical) features (e.g. face features),
- standard biometric features,
- non-standard biometrics e.g. coronary archeries layouts (deformations, pathologies).

Figure 4 presents a description of the operation of biometric data analysis systems supplemented with elements of the semantic analysis of image data. This type of analysis makes it possible to assign a given person his/her genetic information in a coded form, biometric data, physical features and possible lesions. This multi-stage process of personal identification significantly reduces the possibility of an error due to the incorrect process of reasoning and personal verification.

The above vectors may also contain information on other lesions of a given person, e.g. those in coronary arteries, lesions/deformation in internal organs. Such information can be used for an in-depth data analysis which is not carried out by traditional verification systems, but which can, in individual cases, be used for complex personal identification problems.

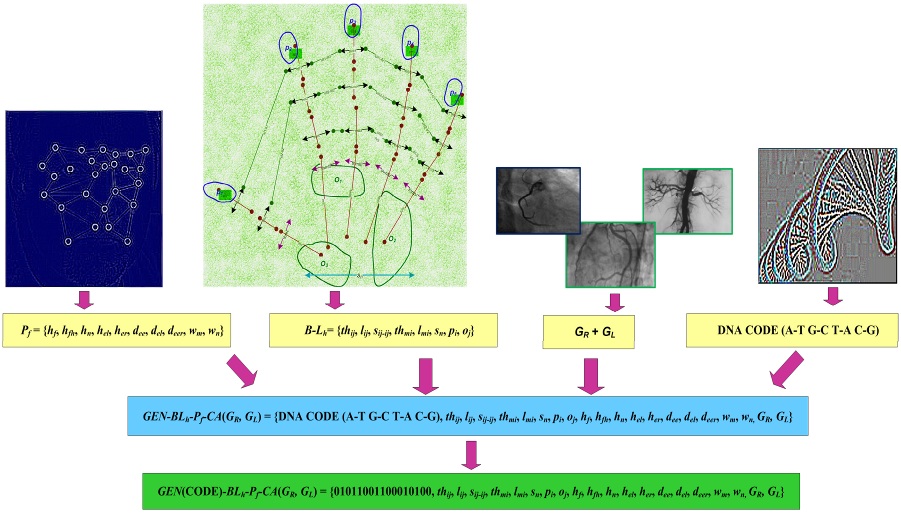

Fig. 4. A biometric data analysis system in CPIAIS systems

4 Conclusion

The idea of biometric data analysis in personal identification and verification systems carried out using CPIAIS cognitive systems presented here allows analysing and interpreting complex (very extensive) data sets. Systems of this kind can analyse various data sets (personal, physical and biometric features plus selected organs pathologies). This variety of data also allows various analysis methods to be employed. The ability to collect information on individual human organs and personal features, the occurrence of lesions as well as the DNA code in the knowledge bases of cognitive systems offers opportunities of enhancing CPIAIS systems with freely chosen data set.

Processes of modelling data stored in CPIAIS systems allow the personal data kept in cognitive systems to be made completely secret.

Acknowledgement. This work has been supported by the National Science Centre, Republic of Poland, under project number N N516 478940.

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