Personal Identification Based on Cognitive Analysis of Selected Medical Visualization

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Abstract

In this publication will be proposed a new algorithm of personal identification based on selected non-standard visual patterns in the form of biomedical visualization. The proposed solutions will be illustrated on the example of using intelligent information systems applied 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 visual patterns, as well as using feature vector in cryptographic procedures.

Keywords: cryptography, cognitive systems, semantic image analysis, personal identification processes.

1 Introduction

A new approach for personal authentication based on visual biometric patterns in the form of selected medical visualization was proposed. The novelty of this approach lays on using cognitive vision systems for extraction of personal information from medical visualization obtained during examination. Usually cognitive systems [2, 1, 5] can be used to semantically analyze pathologies of human organs [6, 8], but as will be show it also may be applied for personal and identification analyses Figure 1. Semantic analysis is carried out in systems founded on cognitive resonance [7, 9] which identifies the compliance between some expectations generated according expert's knowledge, and the real features collected in the system [7, 9].

2 Personal Features for Identification Procedure

Information systems that could semantically analyze medical visualization are essentially based on the use of linguistic grammar formalisms e.g. graph, a tree or a sequential grammar [11]. 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 analyzed. 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. Such parameters are presented in the feature set defined as follows [9]:

- the height of face
- the forehead height

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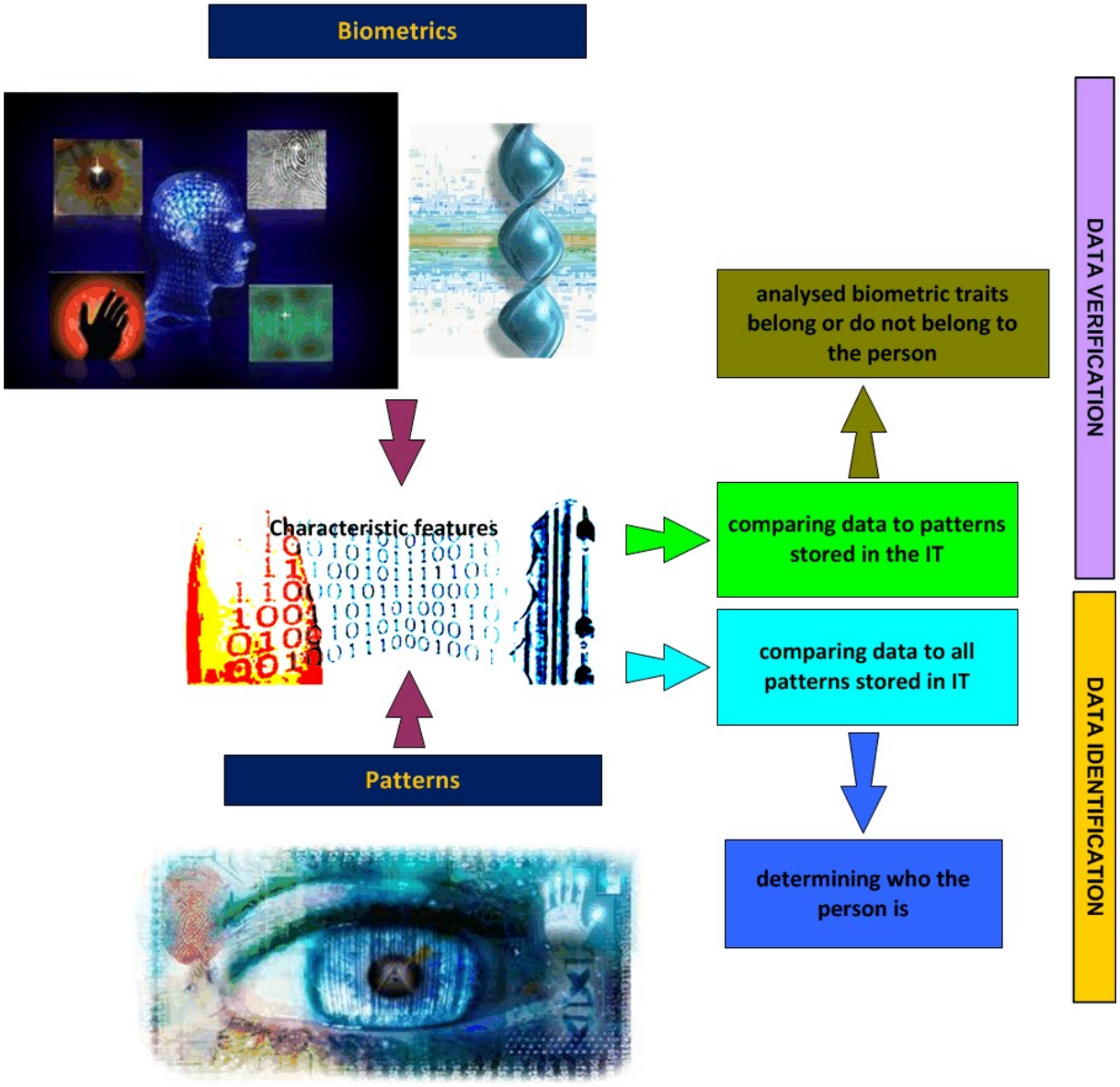

Figure 1: Personal verification and identification processes

- the height of nose
- the height of the left eye
- the height of the right eye
- distance between inter corners of the eye
- distance between outer corners of the eye
- distance between external ends of the ears
- the width of mouth, and the width of nose

The proposed feature set 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 [7, 10]:

- the thickness of the bones of the i^{th} finger and the j^{th} phalanx
- the length of the bones of the i^{th} finger and the j^{th} phalanx
- the size of areas between individual hand bones
- the thickness of the i^{th} metacarpus bone
- the length of the i^{th} metacarpus bone
- the size of wrist bones
- the print of the i^{th} finger of the hand (from one to five)
- the shape of one of the three biometric lines of the palm

The above mentioned set defines the biometric features and shapes of handprints as well as the shape of fingerprints, which make it possible to conduct a biometric analysis (Figure 2). Data on biometric features stored in the analyzing system supports personal identification and personal verification.

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 - GR for the right coronary artery and the RL 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. 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 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 Sequences for Cognitive Personal Analysis

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

- the DNA personal code
- individual (physical) features (e.g. face features)

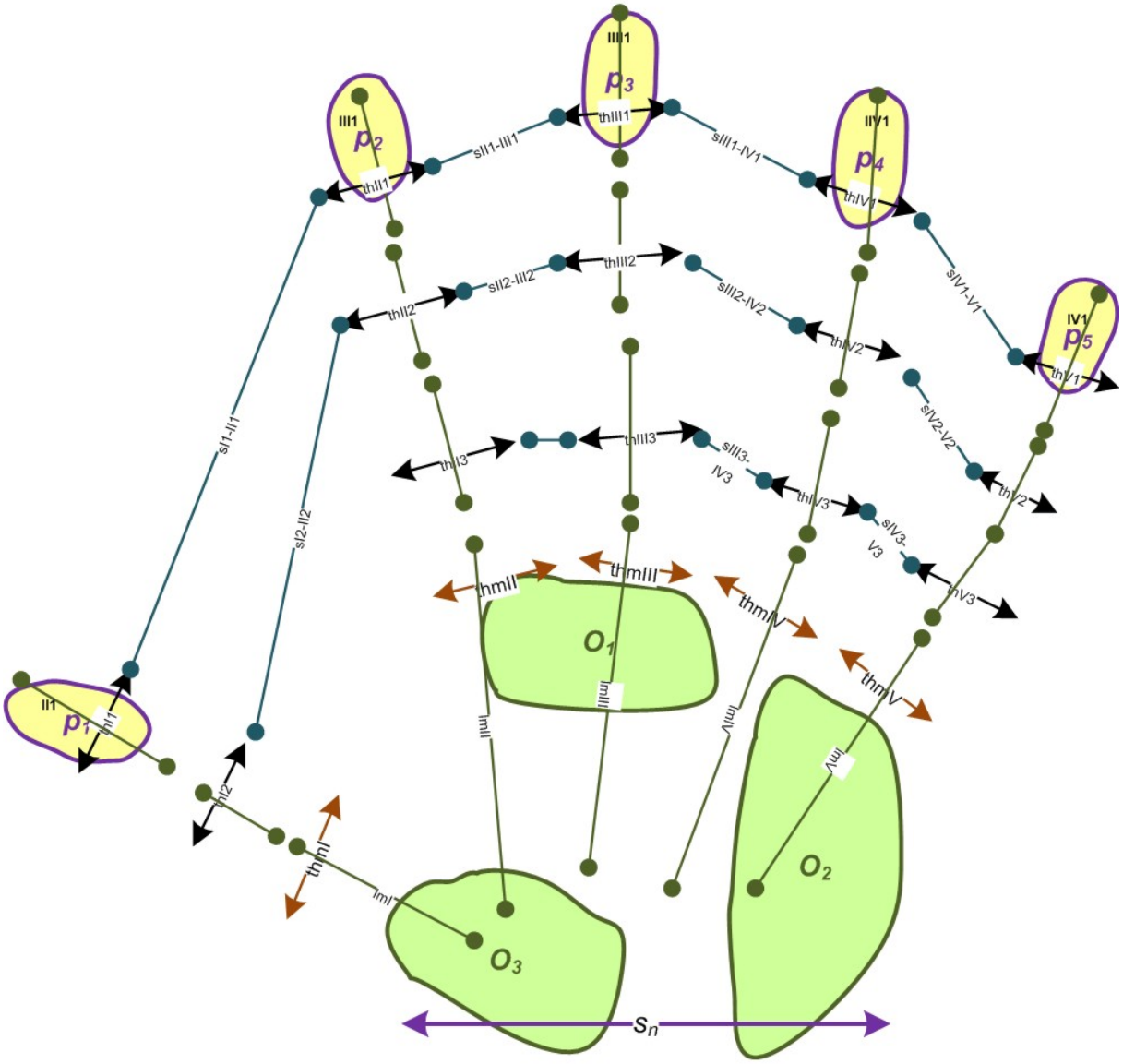

Figure 2: Elements of hand personal feature vector

- standard biometric features
- non-standard biometrics e.g. coronary archeries layouts (deformations, pathologies)

Figure 3 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 presented vectors may also contain information on other lesions of a given person, e.g. those in coronary arteries, lesions/deformation in internal organs, or even brain perfusion abnormalities [4, 3]. Such information can be used for an in-depth data analysis which is not carried out by traditional

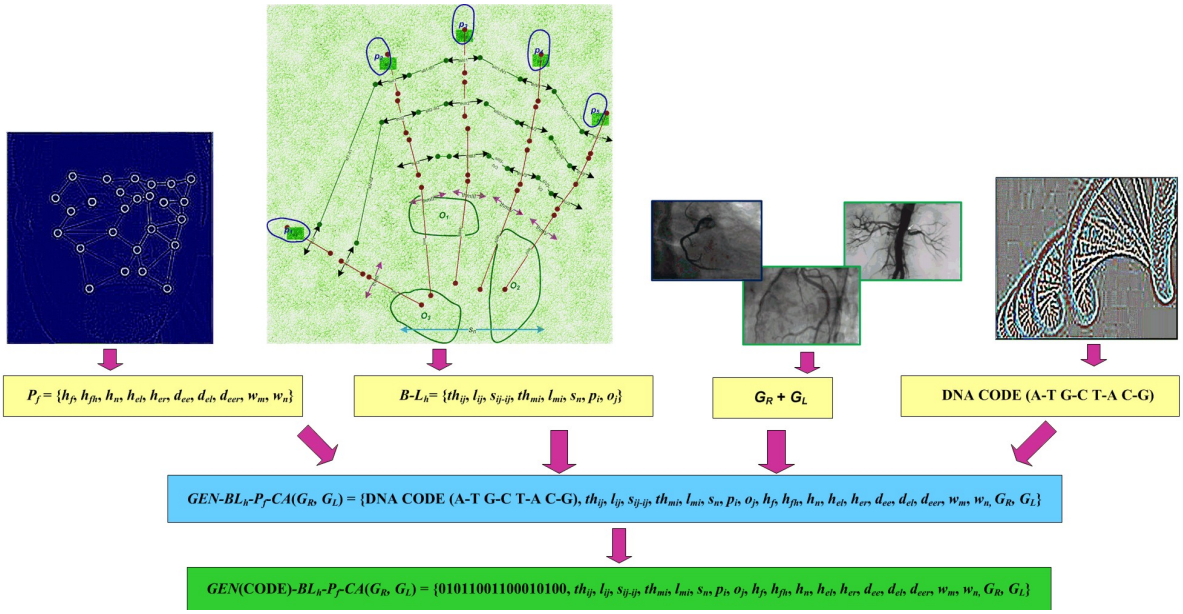

Figure 3: A biometric data analysis system

verification systems, but which can, in individual cases, be used for complex personal identification problems.

4 Conclusion

The presented general idea of biometric data analysis in personal identification and verification systems allows analysing and interpreting very extensive personal data sets. Systems of this type can analyse various personal feature vectors containing personal, physical and biometric information. 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 cognitive systems with freely chosen data set.

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Marek R. Ogiela works at the AGH University of Science and Technology in Krakow. In 1992 graduated from the Mathematics and Physics Department at the Jagiellonian University. In 1996 for his honours doctoral thesis on syntactic methods of analysis and image recognition he was awarded the title of Doctor of Control Engineering and Robotics at the Faculty of Electrical, Automatic Control, Computer Science and Electronic Engineering of the AGH University of Science and Technology. In 2001 he was awarded the title of Doctor Habilitated in Computer Science for his research on medical image automatic analysis and understanding. In 2005 he received a professor title in technical sciences. Member of numerous world scientific associations (IEEE-Senior Member, SPIE-Senior Member, SIIM etc.) as well as of the Forecast Committee 'Poland 2000 Plus' of the Polish Academy of Science and member of Interdisciplinary Scientific Committee of the Polish Academy of Arts and Sciences (Bio cybernetics and Biomedical Engineering Section in years 2003-2011). Author of more than 220 scientific international publications on pattern recognition and image understanding, artificial intelligence, IT systems and biocybernetics. Author of recognised monographs in the field of cryptography and IT techniques; author of an innovative approach to cognitive medical image analysis. For his achievements in these fields he was awarded many prestigious scientific honors, including Prof. Takliński's award (twice) and the first winner of Prof. Engel's award.

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