Journal of Network and Computer Applications 38 (2014) 34–42

Contents lists available at ScienceDirect

Journal of Network and Computer Applications

journal homepage: www.elsevier.com/locate/jnca

Cognitive systems and bio-inspired computing in homeland security

Lidia Ogiela *, Marek R. Ogiela

AGH University of Science and Technology, Al. Mickiewicza 30, PL-30-059 Krakow, Poland

ARTICLE INFO

Article history:
Received 29 November 2012
Received in revised form
10 March 2013
Accepted 8 May 2013
Available online 20 May 2013

Keywords:
Identification processes
Personal analysis
Cognitive systems

ABSTRACT

This publication primarily deals with biological modelling in the context of data protection and securing confidential information from disclosure or being accessed by third parties. Biological modelling of information/data of an individual, personal and unique nature, namely individual biometrics, leads to extracting information classes necessary for personal data protection processes. Such processes can be used to secure various types of data. Adding semantic data analysis processes to IT system classes which are used to conceal processes of personal data management offers opportunities for semantically analysing and interpreting data while it is being disclosed/decrypted.

1. Introduction

One of the area of homeland security is wide possibilities of performing personal identification for particular bodies or citizens.

There are many circumstances in which state agencies should allow to perform a biometric identification e.g. airports transportation, banking systems or personal id infrastructure, forensic investigation at the crime scene or similar. All such task required to have abilities for quick and convenient acquisition of personal biometric data, patterns or information. But having such personal information sometimes may generate some additional problems with management (Ogiela and Ogiela, 2012b, 2012c) and proper selection of most important personal features which should be used for particular identification task, or even generate problems how can we used such personal information for another purposes beside straight identification. So the main theme of this paper will be connected with the latest achievements in the field of creation and application of cognitive information systems for analysis if personal data, and possible application of such patterns for identification purposes. This may be very important in future homeland security computer systems, and ambient intelligent systems allowing performing ubiquitous human monitoring tasks.

An identification analysis aimed at correctly recognising a given person, and in particular the assignment of the analysed characteristic traits of a given individual to a specific person, are performed by correctly comparing traits with the set of data kept in knowledge bases. The personal data set of a given individual contains all the personal data that is available (i.e. is obtained during the data collection process). The personal data collected in the personal data set makes it possible to define characteristic traits of a given individual which will form the basis of the verification analysis. The verification of a person must be unambiguous, as it is not acceptable for the personal data collected in the system to point to more than one person characterised by specific traits. Thus the verification process must be unambiguous. If it is not, then the set of characteristic features must be supplemented with additional personal data which will make the identification process unambiguous (Colombini and Colella, 2012).

Biometric analysis processes are conducted by a class of systems called Cognitive Personal Information Analysis and Identification Systems—CPIAIS. These systems represent one of three sub-classes of cognitive data analysis systems (Fig. 1) whose operation is based on the cognitive resonance processes and inference (Fig. 2, Ogiela, 2008, 2010a, 2010b, 2012; Ogiela and Ogiela, 2009, 2010, 2011, 2012a).

Cognitive data analysis systems presented in Fig. 1 are dedicated for various task connected with deeper semantic analysis of complex data. The extended classification of such systems are very broad (Ogiela and Ogiela, 2012a) and start from economic data analysis, over visual image semantic description and classification towards extraction of personal and biometric information for performing human authentication tasks.

All classes of cognitive information systems are based on cognitive resonance processes presented in Fig. 2. The main concept of such systems is inference between some expectation, which usually are mined in the system knowledge database, and some real features (or parameters) which are obtained on-line during system analysis. As a result of such inference the resonance module could evaluate final semantic information about the merit sense of analysed patterns.

* Corresponding author. Tel.: +48 12 617 28 30.
E-mail addresses: logiela@agh.edu.pl (L. Ogiela), mogiela@agh.edu.pl (M.R. Ogiela).

1084-8045/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.jnca.2013.05.005

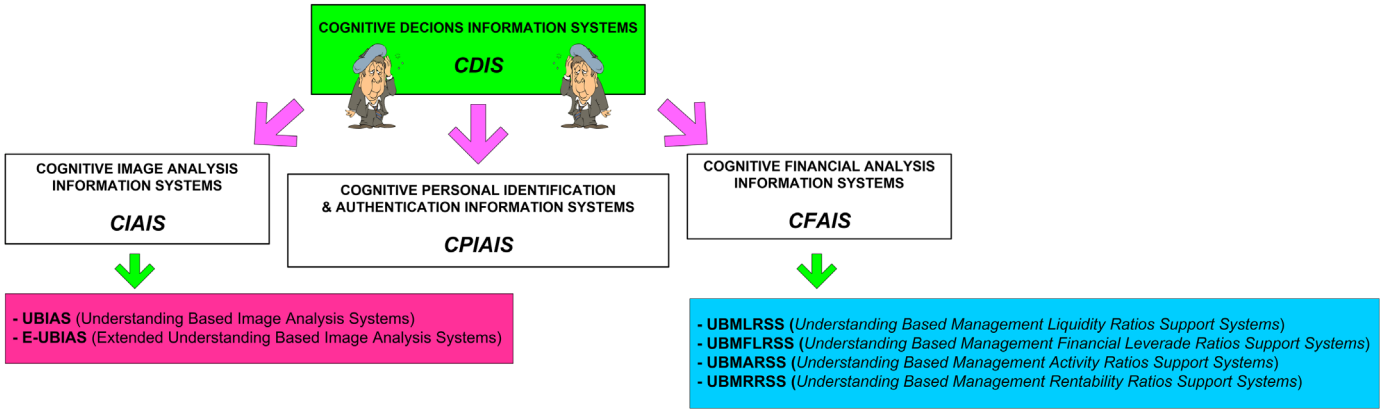

Fig. 1. Cognitive decision information systems.

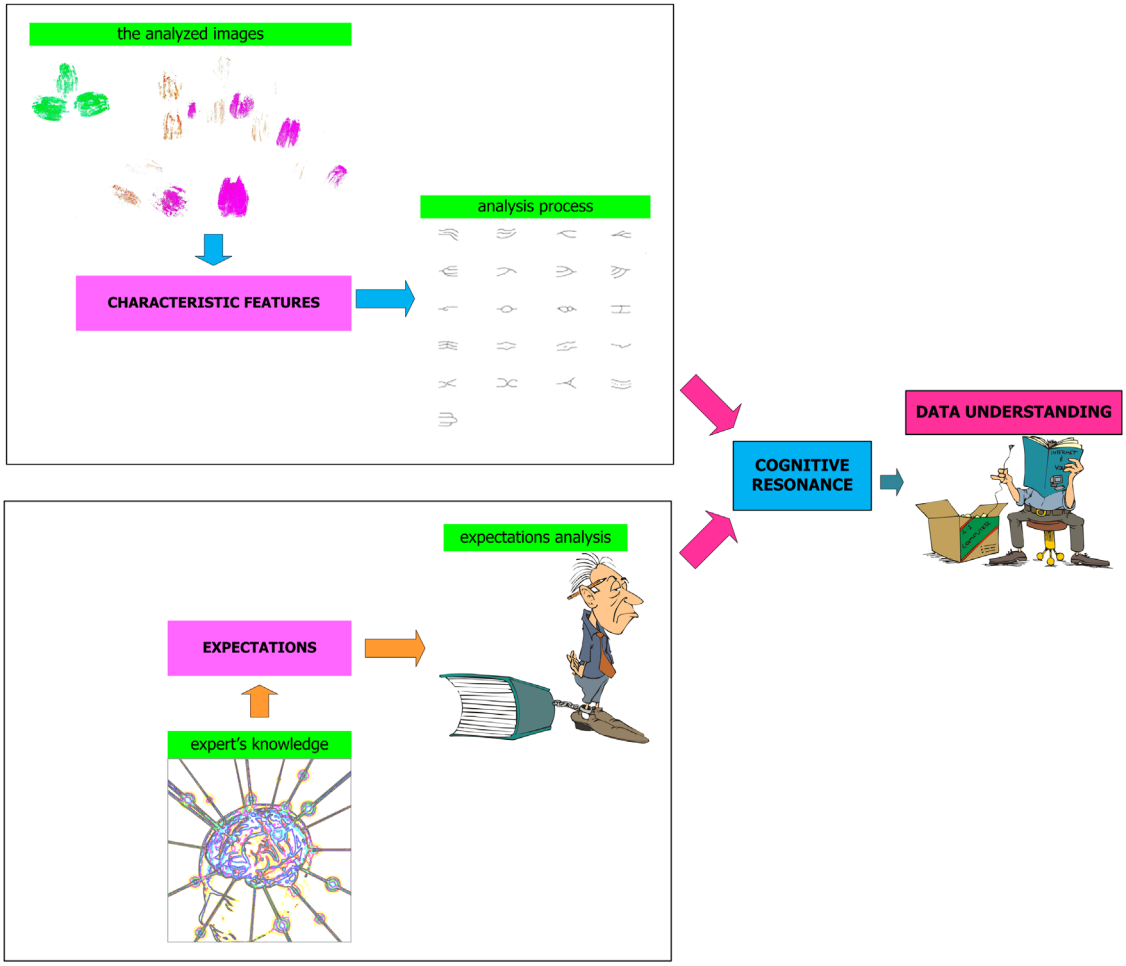

Fig. 2. Cognitive resonance process in Cognitive Systems.

The CPIAIS class of systems presented below is used for identification analyses carried out based on the description and the analysis of the shape of handprint lines (Ogiela, 2012).

2. Personal analysis of biometrics in CPIAIS systems

Various personal data can be subjected to biometric analyses. One of their types is the hand/fingerprint line analysis. The lines whose shape can be biometrically analysed may be both those of the handprint, and those of fingerprints. Every one of us, as a human, has a diverse and unique pattern of hand/fingerprint lines. This pattern forms in the very beginning of our life, between the 100th and the 120th day of the foetal life. This process occurs when the smooth skin of human fingertips shrinks. The characteristic dimensions involved in identifying the shape of fingerprint lines define the height of fingerprint ridges above the creases, which ranges from 0.1 to 0.4 mm, and their width, ranging from 0.2 to