

ABSTRACT

Within the framework of the current habilitation thesis, my scientific, professional and academic achievements are summarized over a period starting with May 2001 (the date when my PhD thesis was defended, then certified by Minister's Order 4202/27.07.2001) until present (2014). Some of my national and international research grants, important papers, books, patents, teaching activities/materials are also detailed in the context of the actual stage of the scientific domain of electronics and telecommunications with emphasis on the innovative aspects and personal contributions.

The first part of the thesis is constituted by the present abstract (both English and Romanian versions).

The second part of the current thesis refers to the:

- Overview of activity, in which I presented the most prominent research, professional and academic achievements (list of publications and grants classified in four main research topics, newly introduced disciplines, taught courses, contribution to the development of the academic curricula, invited professor, students internship, conducting diploma and dissertation theses, endowed laboratories and library, international cooperation, management activities, etc.). The most important mentioned aspects are: a number of 53 research articles published in the above mentioned period, 12 research grants (7 as grant/contract director) and 6 books.
- Technical presentation in which four main research topics are identified:
 - *Computational intelligence in autonomous mobile robotics*. First work presented here is interested in environment representation which permits the robot to know if it goes in the right direction by acquiring a spatial models of the robot's physical environment using a non-metric/qualitative approach. Perceptual landmarks are used to generate maps and to localise the robot with respect to these landmarks. Second work presented within the framework of the above mentioned topic deals with genetic algorithm based methods for finding optimal structure for a neural network (weights and biases) and for a fuzzy controller (rule set) to control a group of mobile autonomous robots. The goal of the robots, namely catching the targets, could be fulfilled only through an emergent social behaviour observed in our experimental results.
 - *Artificial intelligence paradigms for human face identification*. Previous works has shown that Gabor feature extraction is one of the most effective techniques employed for the human face recognition problem. However, the selection of a particular set of Gabor filters is often problematic and, also the computational requirements are considerable. We propose an alternative feature extraction method - the Interest Operator - to be applied for the facial recognition problem. On AT&T public facial database, the system has achieved an average recognition rate of 95.2 percent using Gabor Approach and 94.7 percent using the Interest Operator. The second contribution in this field is represented by a combination between an Interest Operator based feature extraction technique and a k-NN statistical classifier having the parameters determined using a pattern search

based optimization technique. This approach enables us to achieve both higher classification accuracy and faster processing time.

- *Soft computing based face expression recognition*. The aim of the first presented work is to identify key representative approaches for facial expression recognition research in the past ten years (2003-2012). The interest in creating such an overview is multifarious. By selecting the most interesting approaches, we want to focus the attention to new techniques and methodologies that may be of high interest to the researchers in the field of facial imagery. Moreover, this selection can be a useful indicator of the areas that will constitute the future research trends. The second detailed work concerns a layered fuzzy facial expression generation of a virtual agent. In this model, social, emotional and physiological layers contribute to the fuzzy facial expression generation.
- *3D biometrics*. In the first work, using combined skeletal tracking and depth information, a biometric person identification is performed. All these features are provided by a low cost 3D acquisition system, the Kinect sensor [Kinect12]. This information is further processed using standard image processing (PCA feature extraction) and machine learning (distance-based classifier) techniques. The second work employs the Time-of-Flight (ToF) principle - employed in certain range imaging 3D cameras. According to it, the measurement distance is derived from the propagation time of the light pulse between the camera and the subject for each point of the image. Then we describe the development of UPT ToF 3D Hand Gesture Database (UPT-ToF3D-HGDB). It represents, according to the best of our knowledge, the single database of this type which is publicly available.

It is worth noticing that the main results achieved in *Computational intelligence in autonomous mobile robotics field* are identified in the Section 3. References, subsection 3.2 List of publications by [RobYear-No] and are in number of 19 papers. Also four research grants tackle a similar topic (see §3.3, [SIARAS2005], [ROBOTS2004], [SYMBOLIC2003], [AI2003]). The second research direction, namely *human face identification* has been treated in 8 publications (referred by [FaceIDYear-No] in § 3.3) and in the following grants: [VIDEO2011], [NEURAL2006], [AI2005], [TRACK2005]. The third problematic, *face expression analysis and recognition* has been investigated in a number of 8 papers (see references with acronym [ExprYear-No]) and 2 research grants ([EXPR2011], [EMO2010]). The results regarding the last research direction, 3D techniques for biometrics, were published in 6 scientific publications (see [Bio2013-1], [Bio2013-2], [Bio2013-3], [Bio2012-1], [Bio2006-1], [Bio2004-1] from §3.2) and one patent [Gui2012].

- My future research, professional and academic career development plans along with possible implementation means. Here, new computational intelligence paradigms are intended to be in depth studied (e.g. Liquid State Machines [Rob2011-1]) and new implementation solutions are to be proposed (e.g. those General Purpose – GPU based as presented in [Rob2012-1]). Also I intend to investigate a new research field in cooperation with researchers from “Victor Babes” University of Medicine and Pharmacy Timișoara concerning a computer-assisted diagnosis system for the improvement of the medical decision in contrast enhanced ultrasound imagery for focal liver lesions.

The third section is dedicated to the references.