TECHNICAL UNIVERSITY
OF CLUJ-NAPOCA, ROMANIA

Fundamental field: Engineering
Specialisation: Electronics, Telecommunications and Information Technology

HABILITATION THESIS
– ABSTRACT –

Contributions to the Use of Information Technology and Data Processing

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This thesis, titled "***Contributions to the Use of Information Technology and Data Processing***", summarizes the professional development and key elements of the candidate *Șerban Nicolae MEZA's* career path to support the request to obtain the ability to coordinate research activity at doctoral level in the ***field of engineering - electronics, telecommunications and nanotechnology***. The emphasis is on the activity carried out since 2013, when the doctoral thesis entitled "*Contributions to the development of 2D & 3D vision systems*" developed under the guidance of Prof.Eng. Aurel VLAICU, PhD, was publicly defended at the Technical University of Cluj-Napoca.

In general, the effort and activity of the candidate took place within the Technical University of Cluj-Napoca, as ***an academic of the Department of Communications***, Faculty of Electronics, Telecommunications and Information Technology, respectively as a member of the ***Laboratory of Multimedia Systems and Applications***, part of the Centre for Multimedia and Telecommunications Technologies. Benefiting from two complementary specializations at the Bachelor's level, that of electronics engineer, telecommunications specialization (in English)[1] - graduate as head of promotion in 2007, respectively, licensed economist, business administration specialization[2], and later a specialization at master's level[1] in signal and image processing (in French), there has always been an openness to interdisciplinarity and diversity in the concerns and interests manifested. Thus, scientific, professional, and academic achievements are manifested in several specific directions which have as common denominator information technology and its use and, respectively, data processing, usually in the form of images.

The habilitation thesis is composed of a first part (chapters 1,2,2,3,4,5,6), that presents the author's achievements in each of the dimensions of the university academic career and the results obtained in the scientific field, the second part (chapters 7,8,9,10), that presents the plans for the evolution and further development of the career, and a last part (chapter 11) containing the analysis of professional risks and general conclusions.

The first chapter presents a summary of the achievements in each of the components of the academic career: the teaching component, the dissemination and impact component of research activities, involvement in projects, institutional development, and, respectively, the relationship with scientific community as a reviewer and the socio-economic actors.

First, the contributions to the updating of the content and material base for the coordinated subjects are listed: ***Applied Informatics*** (fundamental subject of the field of Electronic Engineering and Telecommunications, compulsory in the curriculum) year 1 Bachelor in Engineering with teaching in Romanian, ***Television*** (field subject, compulsory in curriculum) - year 4 Bachelor in Engineering with teaching in Romanian, respectively English, and ***Management of Personal Data in IT Systems*** - year 1 Master's in Applied Engineering (Technologies, Systems and applications for eActivities) with teaching in Romanian. This extends also the contributions to the laboratory and project activities from the Multimedia Technologies subject (field subject) - year 4 Bachelor in Engineering with teaching in Romanian, respectively English.

Regarding the scientific achievements known and recognized in the academic community mainly through dissemination in the form of papers presented at scientific events such as conferences or workshops or articles published in journals, a summary is given. In this context, ***42 scientific articles with ISI Web of Science (WoS)*** indexing have been published in the academic career, so far. These are associated with the public Web of Science ResearcherID

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[1] Technical University of Cluj-Napoca, Faculty of Electronics and Telecommunications
[2] "Babes-Bolyai" University, Business Faculty, graduated in 2006

profile of the author[3] ABH-2578-2021. Of the 42 articles, ***4 are journal articles, with Q2/Q1 indexing*** in the fundamental field of the thesis, with a cumulative total impact factor of 16.018. In terms of academic recognition, the indexed publications have been ***cited 74 times in other ISI Web of Science (WoS) indexed papers***. Also, the research activity undertaken is recognized by the ***publication of 2 patents requests*** at national level.

Furthermore, regarding the research activity, ***3 coordinated projects won through competition*** are presented, in reverse chronological order.

The project "*Research and Development of an Intelligent System for Efficient Economic and Sustainable Application of Phytosanitary Treatments in Vine Culture*", https://vinivitis.utcluj.ro/, part of the complex project "*Complex system, integrated for optimization technology and superior recovery of wine by-products (VINIVITIS)*", project code PN-III-P1-1.2-PCCDI-2017-0251 - 4, aimed at providing solutions to increase the economic efficiency and sustainability of the application of phytosanitary treatments in vine cultivation by intelligently (e.g. based on the use of information technology, sensors and data processing) applying phytosanitary treatments only in areas that require it. As a research effort, the activities focused on identifying solutions for the analysis and understanding of the characteristics of the vineyard using ultrasonic and/or image based sensors and, respectively, investigate new algorithms and processing methods for describing the data and classify it (feature vectors, machine learning, neural networks, etc.).

Another coordination activity was dedicated to the implementation of the project "*University school for initial and continuous training of teachers and trainers in the field of technical and engineering specializations - DIDATEC*", having both an operational component, training and skill development for university teachers, and a research one, dedicated to the use of technology in the teaching process characteristic for the technical higher education, which resulted in the publication of 2 scientific papers with ISI WoS indexing.

A third coordinated project, won through a national competition, titled "*Distributed Video Coding*", with the code CNCSIS BD 337, concentrated on identify alternative methods for the re-distribution of the computation complexity between the transmitter (encoder) and the receiver (decoder) in video streaming scenarios.

In the subsequent chapters, the thesis details the results obtained in the scientific field in various collaborative contexts and on the various topics of interest, following the progress made and making references to existing scientific publications in this regard. Thus, it begins with the contributions made to the development of data acquisition methods (photo images, voice signal, ultrasound) - Chapter 2. It continues, in Chapter 3, with the research undertaken in the field of data processing such as hyperspectral images and the presentation, in Chapter 4, of the improvements to the methods for describing and classifying images of plants and different crops, both of which are applicable to the field of precision agriculture. It follows, in Chapter 5, the brief presentation of the contributions to the digitization of educational scenarios using information technology in general, and the technology related to virtual and augmented reality solutions, respectively. Chapter 6 lists other contributions resulting from various collaborations over time in the context of research activities and materialized with scientific publications disseminated in the academic community.

The research activity presented occupies several specific directions, having as common denominator information technology and its use and, respectively, data processing, usually in the form of images, highlighting concerns and interests open to interdisciplinarity and diversity: from data acquisition (photographic images, voice signal, ultrasound) in Chapter 2 for the processing of hyperspectral data and methods of description and classification of data for precision agriculture (Chapters 3 and 4); from contributions to the

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[3] https://publons.com/researcher/4883968/serban-nicolae-meza/

digitization of educational scenarios using information technology in general, and virtual reality and augmented reality technology (Chapter 5), respectively, to approaches to improving the safety and security of human life such as the classification and detection of abnormal video events, or identifying hate speech (Chapter 6).

The second part of the thesis details the plans for further career development. After a preliminary self-analysis (Chapter 7), the vision, mission and professional objectives are formulated (Chapter 8), followed by the planned actions (Chapter 9). The vision of the professional path aims at "*developing a career based on combining technical-engineering aspects in the field of data processing, information systems and information security applied in the development of new systems, concepts and solutions to improve people's lives, with the satisfaction of assisting and learning others based on the experience gained, carried out in a competitive environment, interdisciplinary, ethical, and of high standing and professional recognition*", having as mission, (1) from a teaching point of view, always to offer the most relevant information and tools for learning for students so that they are competitive in the labour market, and the skills acquired in the guided subjects to represent a real milestone in the development of their subsequent career, (2) from a professional / research point of view, to contribute through research projects to the development of the field and the advancement of knowledge, and lastly, (3) from a personal point of view, to establish lasting friendships and professional collaboration based on respect and mutual recognition of value with the contemporary professional and university elite.

Chapter 10 details ***the 3 future research directions considered***: (1) the acquisition and processing of data and information (mainly at the level of image / video information); (2) the use of technology in education, in particular new approaches to virtual reality and augmented reality; and (3) the management of data and information containing personal data, and the automation of information flows using technology.

Thus, in the short and medium term, ***the research objectives*** are (1) to identify new methods of combining the process of acquiring plant data with the process of automatic location and mapping of the environment (e.g. SLAM - simultaneous localization and mapping), (2) to investigate the ways in which neural network structures can contribute to the processing of data extracted from information collected in scenarios that allow them to run on autonomous equipment (e.g. robots), in-situ at the crop level, with constraints related to the reduction of complexity and the need for large annotated databases for pre-training, (3) to identify scenarios and activities that can directly benefit from the use of "*immersion*" and "*information expansion*" at multi-modal level for the development of new skills and abilities in the teaching-learning process and, respectively, (4) the investigation of privacy enhancing technologies (PET) and the concepts associated with the digital identity of people ("*digital identity*", "*digital self*") in the context of the paradox of "*maintaining confidentiality - traceability of digital actions*".

The thesis concludes with the analysis of occupational risks (chapter 11) and the final conclusions, reiterating the fulfilment of the imposed and necessary conditions for obtaining the right to guide doctoral activities (habilitation) in the field of electronics and telecommunications.