MINISTRY OF EDUCATION AND RESEARCH

TECHNICAL UNIVERSITY
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Fundamental field: Engineering
Specialization: Computer Science and Information Technology

HABILITATION THESIS
– ABSTRACT –

Applications of the Computer Vision in Autonomous Driving and Medical Imaging

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The current habilitation thesis entitled "Applications of Computer Vision in Autonomous Vehicle Driving and Medical Imaging" presents the main scientific, professional, and academic achievements attained after receiving the doctoral degree in the field of "Computer Science" on March 12, 2008.

The habilitation thesis is structured into three sections: Scientific and Professional Achievements, Academic Achievements, and Career Evolution and Development Plans. The first section (Scientific and Professional Achievements) is structured into 4 chapters as follows:

Chapter 1 presents the main scientific achievements in the field of computer vision applications in autonomous vehicle driving and consists of 4 subchapters: Barrier Detection for Stereovision-Based ACC Systems, Detection and Localization of Transverse Road Markings in Intersection-Type Scenarios, Models for Object Localization in Multi-Spectral Vision Systems, and Automatic Semantic Annotation of Images Using Traditional Techniques (pre-deep learning).

Chapter 2 presents the main scientific achievements in the field of computer vision applications in medical imaging, divided into 3 subchapters: Lesion Segmentation in Mammographic Images, Semi-Automatic Annotation and Segmentation Methods for Unlabeled US Images, and 3D Reconstruction of Anatomical Structures from CT Images.

Chapter 3 presents my involvement in research projects both as project director and as a member of research teams, my involvement in institutional projects, and the interdisciplinary nature of this involvement.

Chapter 4 presents the recognition and impact of the research activities quantified through specific metrics, participation in the scientific and organizing committees of international journals and conferences, and the scientific awards received.

The second section of the thesis (Academic Achievements) summarizes, in Chapter 5, the teaching, supervision, and mentoring activities carried out with bachelor, master, and doctoral students.

The final section of the thesis (Career Evolution and Development Plans) presents the main objectives pursued in the development of my professional, scientific, and academic career, as well as the final conclusions of the thesis.

My professional and scientific activity during my doctoral studies focused on the field of computer vision, applied predominantly to advanced driving assistance systems (ADAS – Advanced Driving Assistance Sistems), with emphasis on the development of methods for calibration and self-calibration of the intrinsic and extrinsic parameters of stereovision sensors, evaluation of their accuracy, and evaluation of the accuracy of 3D scene reconstruction and object localization.

In recent years, computer vision has become a highly topical subfield of computer science with an accelerated evolution, along with the integration of artificial intelligence concepts into computer vision, becoming a key component of national and international research and technological development activities. Thus, my postdoctoral work continued along two major directions: applications of computer vision in the field of ADAS systems and Autonomous Driving (AD), and medical imaging, and, to a lesser extent, in the field of perceptual interfaces.

In the field of ADAS and AD applications, I focused on implementing specific tasks used for environment perception, such as: detection and tracking of horizontally structured objects in visible-spectrum traffic scenes, semantic segmentation of the scene, detection and localization of objects in multispectral images (visible + far infrared), both through inter-sensor co-registration and through the use of monocular localization and measurement

models, improvement of camera calibration methods, and their adaptation to multi-spectral vision systems.

In the field of medical imaging, within the research projects that I coordinated or in which I was a team member, I addressed the problem of segmenting anatomical structures of interest using both traditional methods and deep learning methods implemented with convolutional neural networks (CNNs), as well as 3D and 2D reconstruction and visualization of volumetric medical data from multimodal sources (CT, US).

My research activity during the postdoctoral period covered by the habilitation thesis was carried out within 3 research projects coordinated by me as coordinator/scientific lead in the field of medical imaging, and as a member of research teams in 3 international FP7/Horizon 2020 projects and 11 national research projects with varied topics (autonomous driving, medical imaging, automatic understanding and interpretation of visual content). The interdisciplinary nature of the topics addressed led to the strengthening of collaborations both with industry partners and with partners from the medical system. The results of the research activity were disseminated through the publication, as co-author, of 8 articles in Q1 or Q2 WoS-indexed journals, 16 papers in the proceedings of WoS-indexed conferences, 9 papers in the proceedings of BDI-indexed conferences, and one book chapter published by an international publisher. Through the citations they received, the publications contributed to increasing professional visibility both at the individual level (WoS h-index = 10, Scopus h-index = 13, Google Scholar h-index = 16) and at the institutional level. In addition to the professional impact, the activities carried out within the research projects that I coordinated or the complex projects in which I participated (FP7, H2020) contributed to the improvement of my managerial skills.

At the professional level, I continued my activity as a member of the scientific committees of prestigious journals or conferences: IEEE Transactions on Intelligent Transportation Systems, IEEE Transactions on Intelligent Vehicles, Engineering Applications of Artificial Intelligence, Journal of Field Robotics, MDPI, IEEE Intelligent Vehicles Symposium (IV), IEEE International Conference on Intelligent Transportation Systems (ITSC). I also continued my activity as a reviewer and as a member of the organizing committee of the IEEE International Conference on Intelligent Computer Communication and Processing (ICCP).

At the academic level, in addition to teaching and assessment activities in Image Processing (2nd year bachelor's), Human-Computer Interaction (4th year bachelor's), Human-Computer Interface and Human-Computer Interfaces (master's) courses, I continued the ongoing updating of teaching materials in accordance with the theoretical and technological dynamics of the respective fields. I published 2 books and 4 laboratory manuals (new or revised editions). I participated in 4 committees for the review and defense of doctoral theses, and I am involved in the guidance committees of 7 doctoral students. I have collaborated with or supervised numerous doctoral, master, and bachelor students in the preparation of scientific papers. Also, since 2010, I have coordinated the technological practice activities of students in the "Computer Engineering and Information Technology" specialization within the Faculty of Automation and Computer Science. In addition to continuing the activities mentioned above, I will pursue my involvement in creating new courses for the new Artificial Intelligence specialization that will be launched within the bachelor's-level Computer Science programs.

At the professional level, I intend to improve my specialized knowledge in the application of artificial intelligence methods in computer vision and to diversify my reviewing activity, with greater emphasis on the field of medical imaging. At the level of scientific activity, I will pursue the involvement of doctoral students in research topics of interest or

related to ongoing research projects, attracting research funding by applying to national or European competitions as well as private funding, in order to allow doctoral students to focus exclusively on research activity within the University. I will continue to pursue involvement in research topics of interest in the fields of medical imaging, perceptual interfaces, advanced vehicle driving assistance systems, and autonomous robots.