Universitatea *Transilvania* din Braşov

HABILITATION THESIS
SUMMARY

Title: **VIRTUAL REALITY (VR) AND AUGMENTED REALITY (AR) TECHNOLOGIES USED IN ENGINEERING, MEDICINE AND HERITAGE**

Domain: **MECHANICAL ENGINEERING**

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A. SUMMARY

This paper presents some results of the research activities carried out after obtaining the title of PhD at Transilvania University of Brasov in 2004, with thesis named *Theoretical and experimental research on synchronous belts*.

During this period, I continued the research into the thesis area and, on the other hand, since 2007, starting with employment at the University, the research was focused on Virtual Reality - VR and augmented reality - AR technologies (in engineering, medicine, robotics, and heritage).

The best part, research activities were conducted at the Research Centre D10 - *Industrial Computer Science and Robotics* from Research - Development Institute of Transilvania University of Brasov.

According to the instructions of editing, the thesis is divided into two sections: (A) Abstract (B) scientific and professional achievements and development plans and career development, which includes: (B.1) Achievements scientific, professional and academic (B.2) Motion for personal development and (B.3) References.

The main scientific achievements presented herein are made in the areas of Virtual Reality technologies used in engineering, medicine and heritage. On this line, section B.1 of the thesis is divided into four chapters, each covering a subdomain of those mentioned previously and presenting results obtained following the performance of research projects in which the author has been engaged as director, partner responsible or as a simple member. At the bottom of each starting page of the chapters are presented the used sources, with references to them for identification.

In the first chapter are presented relevant results of research in haptic technologies in 1 DOF mechanisms area. Thus, based on the research project *New system type haptic exoskeleton robotics and automation space - EXORAS* 13/2012 (responsible partner) Romanian Space Agency, 2012-2015, were conducted research on the effects of haptics for arm exoskeleton. The following elements are detailed: general considerations about haptics, the operating principle of the 1 DOF mechanism, devices and prototypes built in order to validate the concept, used software and operation method, obtained results. It is also presented a model of a machine tool reconstituted using techniques VR, made for use in learning.

Implementation of VR and AR technologies in medicine was studied with the author's participation in several research projects in the field of medical robotics: *Brachytherapy assisted robotic, an innovative approach in the therapy of inoperable cancers (CHANCE),* 2012-2016 PCCA type 2 ,

173/2012 (responsible partner) and *Prostate biopsy assisted robotic, an innovative method of high accuracy (ROBOCORE),* 2014-2017, Partnerships, no. 247/2014 (member) or in the field of human posture tracking - *System for diagnosis and therapy of spine diseases of the (SPINE)* 2014-2017 Partnerships 2013 no. 227/2014 (project manager). Second and third chapters contain results obtained from these projects.

Thus, in the second chapter are presented 3D technologies for reconstruction of anatomical structures and, on the other hand, techniques and algorithms of pre-planning of brachytherapy procedure using VR technologies: patient and virtual environment modelling (human body, surgery room, tools, equipment), simulated trajectories for brachytherapy needles, the needle paths optimizing.

The third chapter covers a range of technologies results on motion tracking used for establish a human body posture and determining the shape of the spine. There are shown, in addition to the overall context of scientific discoveries in the thematic area, a series of studies, proposals, prototypes, technologies, algorithms, results on diagnosis and treatment of recovering from disorders of the spine position. VR technologies used were: scanning and 3D reconstruction, motion tracking, VRML applications, MATLAB and ADAMS.

Chapter number four presents elements of virtual 3D reconstruction activities of heritage objects, starting buildings from artifacts using VR technologies. Research in this area have been made over the last three years and continues through a Horizon 2020 - Twinning project: *Expanding the Research and Innovation Capacity in Cultural Heritage Virtual Reality Applications (eHeritage),* 2015-2018 (team member). Here were highlighted achievements in the methodologies and equipment used, objectives and are presented several case studies.

In the second section (B.2) are presented the professional development and career scientific and academic plans, including targeted research directions and probable the action modes to implement them.

The third section (B3) containts the references related to the content of the first two sections.