SUMMARY OF HABILITATION THESIS

THEORETICAL AND EXPERIMENTAL RESEARCH ON STRUCTURES AND HISTORICAL BUILDING USING ADVANCES SURVEY ENGINEERING METHODS

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Abstract

Present thesis summarises the research activity of the candidate after defending the PhD Thesis at The Politehnica University of Timisoara and confirmed by The Ministry of Education and Research, on the basis of Order no. 5764, dated 28.11.2006. The research activity and achievements presented here are developed in a few of main thematic directions.

The first one is - **Contribution to applying topographic methods for studying and monitoring terrain and constructions**, which continues and diversifies with new subjects, the topic of the PhD Thesis or others subjects related to this.

It should be noted that the activity of the candidate in the field of special surveying engineering and applying topographic methods for studying and monitoring terrain and constructions (20 years of research in this field), from the beginning, from September 1996, until the defending of PhD Thesis, and for the post-thesis period, is in line with the fields of research of the department of Overland Communication Ways, Foundation and Cadastre and especially with the team from Terrestrial Measurements and Cadastre from Faculty of Civil Engineering, Politehnica University of Timisoara, but also with private companies and departments from EU universities.

The new subjects of research in the post-thesis period can be synthetized in four distinguish them, developed in the present thesis, each of them related to the following aspects:

- Developing methods and models to evaluate and determine the real deformations of terrain ans structures.
- Reverse Engineering and Laser Scan Technology applied to Cultural Heritage domain, Development of 3D Models for Cultural Heritage sites;
- Using Open Source and Low-Cost solutions and GIS Platforms for different users to architectural and cultural applications;
- Educational platforms for e-learning processes.

One on my research area enhanced by me at Politehnica University Timisoara is related to developing new **methods and models to monitoring the dynamic deformations of structures** – this fact is proven by scientific papers published in ISI and BDI journals. This preoccupation emerged from the fact that the engineering structures, civil construction and historical buildings are subjected to dynamic deformations and also degradation over time. Measurements are taken over minutes, hours, weeks, months or years to a number of targets with the goal of measuring uneven settlements, displacements or long-term permanent or specific deformations. Due to the fact that my main activity has been developed almost entirely together with my colleagues from the aforementioned department, I believe that developing and better understanding of the displacement and deformation phenomena of the engineering structures and also their monitoring is a natural direction followed by the candidate. Moreover, studying these phenomena, led to another research theme, namely historic and old constructions, which meant that this domain has opened new opportunities for research and cooperation. This new directions are presented hereinafter:

Reverse engineering. Historical buildings play an important role in Cultural Heritage scenario: their main value is due overall to age, artistic and structural features and to surrounding environment. In the

last years, the interest of using accurate CH 3D data acquisition for historical, archaeological research and virtual reconstruction documentation is not just a scientific preoccupation but also a recommendation of public authorities.

Besides digital reconstruction, a study on monitoring and analysis of the structure of Cultural Heritage buildings becomes less difficult by testing the parameters that ensure the integrity and safety of the buildings using geodetic methods based on total station, close range photogrammetry or Laser Scan technology. **3D Laser Scan Technology** allows user to produces a high-precision digital reference data that records condition, provides a virtual model for replication, and makes possible easy mass distribution of digital data. The cost and complexity of 3D laser scanning technologies have made 3D scanning impractical for many heritage institutions in the past, but this is changing, as an increasing number of commercial systems are being customized and marketed for heritage applications and also Photogrammetry begun to be used as complementary method to 3D laser scan technologies in domains such as architecture and civil engineering. The study of these technologies as well as comparisons between the resulted 3D models represents one of my goals of the research studies conducted in the last couple of years.

3D Models for Cultural Heritage sites was -and still - representing a continuous preoccupation and as assistant professor and researcher at Politehnica University Timisoara, Department of Land Measurements and Cadastre, I was involved in the process of creating and modeling different objects, e.g. Buildings, Structures, Monuments, Digital Terrain Model (DTM). In this context, one specific target of my research is the development of methods for "re-creating" and promoting 3D Cultural Heritage objects. The results have been published in two papers at ISI journals and ISI conferences.

My findings challenged the conventional assumption that Cultural Heritage, 3D modeling and also **GIS platforms or, even better, webGIS** are the next natural step forward for both conservation and preservation of Cultural Heritage objects, and also for understanding and promoting them. These facts are sustained both by developing and participating in EU programs realized in international consortiums with universities from Greece, Hungary, Slovakia, Austria and Romania in order to obtain results for modeling 3D objects using Low-Cost digital photogrammetry.

Another applicative dimension which included **Open Source solutions** was developed in cooperation with University of Life Science from Norway, Department of Natural Resource and Management. Together with researchers from Norway and some of my students from Politehnica University Timisoara, we established new models for integrating LIDAR data in Open Source GIS platforms by an inter-institutional agreement whose departmental director I was.

Nowadays, in the context of using **Open Source or Low-Cost solutions** and to respond to the needs of applicative research in Cultural Heritage domain, one can mention the program EPOCHE in Greece where I presented and sustained the interest in accurate and rapid Low-Cost solutions for Cultural Heritage data acquisition and processing of 3D archaeological documentation.

As a consequence of the collaborative work between academics, researchers and students, scientific information characterizing the process of **realization of 3D models** using Low-Cost or professional software emerged, the results being published on the internet, which makes reconstruction Cultural Heritage (CH) objects even more attractive. As an outcome of the collaboration between the participating teachers, researches and students, was the applicative research and virtual reconstructions of CH published on the website of the program. Also, together with the unlimited possibilities offered by the World Wide Web, creating physical virtual replicas of Cultural Heritage objects is more and more attracting and interesting.

Educational platforms for e-learning processes are the instrument where all the information and the scientific work is transfer to the students. Current trends in the university network require implementation of the policy for restructuring the higher education system, by focusing on the student's educational activities. The new methods involve experimentation learning based on scenarios, alternative solutions and direct interaction between the student, the subject of learning and the learning environment. In this context, when the institutional support is provided, improvement and diversification of educational offers for geodetic engineering and their correlation with the labour market are defined on two main directions. As regards the bachelor cycle, an online network was implemented for university collaboration to develop the capacity of providing superior competences in Geodesy, mainly for harmonization and standardization of a training program at multi-regional level. For the master cycle, emphasis is put on the use of the Virtual Campus of the Politehnica University Timisoara, system based on Moodle, an open-source platform which is an online educational environment of academic support for all faculties belonging to Politehnica University Timisoara.