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HABILITATION THESIS

The Convergence of Geospatial Technologies in the Analysis and Management of Terrestrial Space: from GNSS and Terrestrial Laser Scanning to Geospatial Intelligence

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Abstract

The present habilitation thesis, entitled *The Convergence of Geospatial Technologies in the Analysis and Management of Terrestrial Space: from GNSS and Terrestrial Laser Scanning to Geospatial Intelligence*, synthesizes the professional and academic experience accumulated over two decades of university teaching and research in the field of geodetic engineering. The work is structured into three parts: scientific, professional, and academic achievements; the career development and evolution plan; and the bibliographic references that support the presented contributions.

Part I highlights the academic background, teaching career, involvement in administrative and leadership activities, and, above all, the scientific research activity. It presents the educational path, beginning with the graduation of the Faculty of Geodesy at the Technical University of Civil Engineering Bucharest (2005), followed by advanced studies in Territorial Information Systems (2006), and the completion of the PhD in Civil Engineering (2010), with the thesis *Positioning and Referenced Localization in Transport Telematics*. The interdisciplinary training was further complemented by a Law degree (2012) and a Master's degree in Educational Management (2013). The professional development includes teaching activities initially at the Technical University of Civil Engineering Bucharest and later at the Military Technical Academy "Ferdinand I", where I currently hold the position of Associate Professor and, since 2023, that of Vice-Dean for Education.

The scientific research activity is structured along five major directions. The first direction concerns **GNSS positioning and engineering applications**. Research focused on the transmission of differential corrections using RTK and VRS methods, developing experimental solutions for their retransmission through combinations of radio and mobile connections. The results were validated through case studies, including the first test conducted in Romania on the use of the national ROMPOS service for Machine Control applications. My contributions demonstrated that the integration of GNSS into engineering workflows optimizes costs and increases the efficiency of construction and infrastructure activities.

The second direction is dedicated to **Terrestrial Laser Scanning (TLS) for 3D modeling and structural monitoring.** Experimental tests were carried out in both laboratory and field settings, ranging from studies of bridge pier scouring to the analysis of adaptive structures and the real-time monitoring of structural behavior. TLS is presented as a precision technology with an essential role in deformation analysis, with direct applications in civil engineering, architecture, heritage preservation, and forestry.

A third direction focuses on the **integration of TLS and GIS**, demonstrating the advantages of data fusion for digital modeling, forest inventory, monitoring, and analysis of the built environment. Research has shown that the association of the two technologies allows for a more complete representation of reality, supports the development of interdisciplinary applications, and provides a solid foundation for engineering decisions.

The fourth direction refers to **multispectral remote sensing for environmental and urban applications**. The research focused on the use of Sentinel satellite data applied to forest monitoring, land-use change assessment, and land surface temperature analysis. These studies

confirmed the role of remote sensing technologies in sustainable planning and natural resource management.

The fifth research direction is **Geospatial Big Data and geospatial intelligence**. This emerging field is represented by the integration of geospatial data into Big Data ecosystems, with the goal of generating actionable intelligence. My research has targeted the collection, storage, and analysis of large volumes of data from heterogeneous sources - sensors, satellites, drones, or social networks - and their transformation into products useful for decision-making. Through recent articles and projects, I have demonstrated the potential of geospatial Big Data in fields such as risk management, security, infrastructure, and emergency response.

The scientific activity is complemented by participation in national and international projects, as director, coordinator, or member of research teams. These projects enabled the validation of theoretical concepts through practical applications and the integration of geospatial technologies in fields such as risk monitoring, crisis management, green infrastructure, and critical infrastructure monitoring. The visibility of the results is confirmed by the publication of ISI/BDI-indexed articles and books, as well as citations in international databases, proving the constant impact of the research.

Part II presents the plan for professional, scientific, and academic development. The development directions include consolidating research in emerging geospatial technologies such as geospatial Big Data, artificial intelligence, and advanced spatio-temporal modeling; diversifying and modernizing teaching activities by integrating digital tools and interactive methods; expanding national and international interdisciplinary collaborations; and engaging in the definition of standards and methodologies at the national level. The medium- and long-term objectives include attaining the title of Full Professor, developing an interdisciplinary research center, and strengthening expertise in geospatial intelligence.

Part III gathers the bibliographic references, including both international specialized literature and my own publications, which constitute the theoretical and applied foundation of the presented research directions.

Overall, the thesis demonstrates a consolidated professional and scientific trajectory, with original contributions in the field of geodetic engineering. Through the convergence of GNSS, TLS, GIS, remote sensing, and Big Data analysis, I propose an integrated vision of geospatial technologies in support of engineering decisions, spatial planning, environmental monitoring, infrastructure development, and security. The results obtained confirm both the academic relevance and the practical applicability of the research, outlining a clear development direction for the post-habilitation stage.