

ABSTRACT

Development of advanced analysis methods and numerical modeling dedicated tools applied in electrical engineering

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The current habilitation thesis makes a synthesis of the research activity done by the candidate and the obtained results, since he got the PhD title in the field of Electrical Engineering from the Technical University of Cluj-Napoca, fact confirmed by the Ministry Order no. 117 from 2nd of June 2004.

The habilitation thesis has been divided into 6 sections. The first section (A) shows the performance of the research context and its integrative approach. Section (B) presents the directions and research skills of the candidate and the Chapter (C) shows the research results obtained by the candidate after his PhD defense, on priority research directions. Scientific results published after obtaining his Ph.D. are summarized in this thesis by referring to these publications (the results are not reproduced in the thesis). These achievements are presented in the overall context of significant scientific achievements and are documented by referring to publications (each reference can be checked (see tables A1, A2)). All original contributions are presented in the context of the current state of the art in the field of electrical engineering.

The candidate is distinguished by enabling his experience in the Technical University of Cluj-Napoca, in three priority research directions at European level and of interest to the two accredited laboratories within ETHM Department: *Laboratory of Modeling and Electromagnetic Compatibility* respectively *Laboratory of Research in Numerical Methods* (<http://research.utcluj.ro/index.php/electrical-engineering-138.html>). These main research fields in which the candidate has contributed since 2004 until today can be grouped in:

- **C1. Development of advanced analysis methods and numerical modeling dedicated tools designed to identify and predict the electromagnetic AC interference problems**
- **C2. Development of techniques for the electric and magnetic field synthesis regarding the reconstruction of the return stroke currents and the specific design application of the solenoid devices. Electromagnetic inverse problems**
- **C3. Development of field synthesis numerical modeling tools applied to electrical circuits stability and synthesis, respectively electromagnetic field synthesis in non-homogeneous media**

In this respect, to support the applicant's professional capabilities and performances, should be mentioned after his PhD title (2004-present): the **7 books**, more than **150 scientific papers** published in journals and /or presented at prestigious international conferences, **4 tutoring theses** completed by members of the *Laboratory of Research in Numerical Methods* (accredited since 2010, whose director is the candidate) and participation as a member/project manager of over **15 research contracts** on above mentioned directions.

From 2004 he is within the Department of Electrotechnics from TUCN, so far being responsible for the courses and applications of Numerical Methods, Complements of Mathematics in Electrical Engineering, Fundamentals of Electrotechnics. The teaching activity was followed by the research activity.

A highlight of the academic career represents the title of associate professor obtained in 2007. This confirmed the achievement of the necessary experience for the next step: research group coordinator and PhD advisor. In the next period, until so far the candidate

has conducted an intensive research in collaboration with colleagues and PhD students from the Department of Electrotechnics. Since 2010 he is the Director of the Numerical Methods Research Laboratory, along with members contributing to the completion of 9 research contracts.

In 2006 was employed on a part-time job, as *Scientific Expert* within the *Managerial Agency for Scientific Research, Innovation and Technology Transfer - Bucharest (AMCSIT)*, where will form his managerial skills regarding the monitoring of innovative projects proposed by industrial environment.

Also, after receiving the PhD title in Electrical Engineering, the candidate performed various research/teaching stages at prestigious universities in Europe (University of Naples Federico II, University degli Studi di Padova, Università di Cagliari, Brunel University, West Macedonian University, Fredrick University of Cyprus, University of Novi Sad, Dublin Institute of Technology). The research/teaching topics were focused on study and development of numerical methods for modeling the electromagnetic field and electromagnetic interference phenomena's, respectively the development of techniques for electromagnetic field synthesis and electrical circuit stability. The mentioned research themes were established as the basis for 3 future grants won as a project manager (financial supported by the national contracting authority) as well another 10 grants won as member in the research team.

The research activities done after 2004, were conducted under the supervision of experienced academics from the Electrotechnics Department of the Technical University of Cluj-Napoca (prof. Emil Simion, prof. Vasile Țopa, prof. Călin Munteanu, prof. Gheoghe Mândru, prof. Ovidiu Micu); in collaboration with academics and specialists from Romanian partner universities (prof. Claudia Popescu, prof. Horia Gavrilă, prof. Mihai Iordache, prof. Daniel Ioan – UPB; prof. Ștefan Kilieny – UPT; dr. Lingvay Iosif – ICPE) and from abroad (prof. Dimitris Labridis, prof. Georgios Christoforidis, prof. Grigoris Pappagianis - Salonic, prof. Daniele Desideri, prof. Alvise Maschio, prof. Roberto Turri – Padova, prof. Gary Taylor – Londra, prof. Nouri Hassan – Newcastle, prof. Michael Conlon – Dublin, prof. Carlos Antunes – Coimbra). During this period the author has also worked as co-coordinator of the PhD students who developed their doctoral thesis under the supervision of prof. Emil Simion and prof. Ovidiu Micu respectively. Many of these doctoral thesis topics were proposed by the candidate, who realized the importance of aligning the research activity within the group to the main European research directions, trends and priorities.

The research carried out by the candidate on the entire professional career (1998-2014) is evidenced by:

- **9** Scientific books (first author - 7);
- **203** Scientific papers published:
 - **19** papers published in ISI Journals
 - **17** papers published in ISI Proceedings
 - **29** articles published in international data bases
 - **138** articles published in B+ journals and/or presented at prestigious international conferences
- **46** citations in ISI/IDB indexed papers

- **3** national research contracts won through competition as director
- **1** international project as team member
- **17** national research contracts won through competition as team member
- **18** research projects for industry

Future career development strategies

It is considered that the research conducted by the applicant is rigorously directed, with a main central goal. Therefore, the candidate will give a special importance to future topic-oriented collaboration and to transfer the obtained knowhow towards the concerned industries. There is belief that future expected research results will meet the concern and expectations of the research groups with whom the applicant have closely worked in the last years. The possible solutions envisaged, for the problems identified as being inconsistently treated so far, present a strong motivation for the author to naturally continue his research in the C1+C2+C3 fields.

As potential for further career development within UTCN it is intended to:

- Integrate research results and collaboration of LCMN as functional structure within the Centre for Applied Electromagnetism - ELMA within UTCN (CNCSIS accredited since 2005) with other UTCN research structures, on the concept of numerical computation software and artificial intelligence algorithms, with applications in electromagnetic interference and numerical modeling of electromagnetic field (Laboratories: Numerical Modeling, Electromagnetic Compatibility, Advanced computational applications, Computational modeling and advanced simulation). Development in collaboration with the laboratories of algorithms for modeling and simulation (easy to use and implement in any professional software, with all related documentation, portability between different computing platforms and operating systems)
- Provide opportunities for education and training: a lot of research results, in the form of methodologies, amendments and regulations, will be the basis of completion of courses (master, postgraduate) of the Technical University of Cluj-Napoca and also of some training courses for industry professionals
- Proposes of PhD topics in the ETHM department: numerical modeling of electromagnetic interference phenomena; synthesis of the electromagnetic field; synthesis of electrical circuits
- In the existing LCMN and LCEM laboratories of the ETHM Department it is sought out to improve performances of a training center for students and PhD students in C1, C2, C3 research fields
- Through the addressed research fields, through the publication / communication of results in literature, I think that will be a positive impact on the visibility of UTCN Research-Development activity, increasing the chances that Research Centers and Laboratories form TUCN being accepted in consortia of international future projects HORIZON 2020
 - As before research results will be embodied in scientific papers and submitted to international conferences with wider theme, but the main targets will be those

domain-specific conferences and specialized publications with visibility, in which paper appreciations are strictly expressed and in which papers preparation requires prior experience (ISI papers: EPSR, COMPEL, IEEE Trans. Mag., IEEE Trans. on EMC, IEEE Trans. on Ind. Applic., IJAEM, ACMM; BDI papers – from international conferences: UPEC, EHE, EPQU, EMC, CEFC, COMPUMAG, ICLP). It intends adopting the new trend assessment research through participation at conferences organized only under the IEEE, and the publication of ISI with high impact factor.

Potential development in the international and national academic/industrial cooperation

- Some applications discussed by the applicant so far, have been studied in the context of ongoing research and collaborations with partners from academia and industry and are directly related to research. The obtained research results it was proved to be useful in industry:
 - ❑ Technology Transfer – towards SC Electrovâlcea SRL, Râmnicu Vâlcea (2008): Comprehensive and predictive procedures and methodologies applicable to equipment and electrical insulating materials built with customization for underground cables
 - ❑ Technology Transfer – towards TENARIS (2008) Solutions to eliminate stray currents in electric motor bearings continuously operating
 - ❑ Technology Transfer – towards SC Utilitas SRL and Siculus Miercurea Ciuc (2008-2009): *Complex method for investigating the degradation by corrosion of reinforced concrete structures for major historical structures*
 - ❑ Technology Transfer – towards SNTGN Transgaz SA (2011, 2012): Software package for the study of corrosion of gas pipelines, under the influence of overhead power lines with voltages higher than 110 kV
 - ❑ Technology Transfer – towards ENERGOBIT SA (2013): Protection solutions for cable screens
 - ❑ Technology Transfer – towards ROMATSA (2014) Equipment protection solutions of DSN objectives Cluj and Bucharest DR Section PNA / CNS Cluj and Pulsed Electromagnetic surge due to lightning and power supply lines for voice and data circuits
- Continue collaborations with companies whose interest fields intersect with the applicant research directions:
 - ❑ S.N. TRANSGAZ Medias (liquid fuel distribution; technological pipelines, storage and service tanks maintenance) - with which it was signed in 2009 a collaboration contract for dissemination of the research results in this company; Dr. Eng. Vlad Pavlovschi - director of Development-Research Department TRANSGAZ, who together with the project manager published 3 articles in 2008); S.C. DISTRIGAZ NORD S.A. Târgu-Mureş (design, execution and maintenance of gas networks, gas distribution); S.C. METAL BETON S.A. Cluj-Napoca (design and execution of technological pipeline networks, storage tanks and distribution stations); S.N.

- C.F.R. General Directorate IFTE (design, execution and maintenance of fixed electric traction installations); ROMCATTEL (storage, bottling and marketing of liquefied petroleum gas), LINET Nowcast; S.C. ELECTROMONTAJ S.A. Cluj-Napoca (design and execution of high-power, low and medium voltage lines); S.C. ELECTRICA S.A. Distribution Branch Cluj (distribution of electricity and energy services);
- Strengthening a very useful practical guide for designers, builders and managers involved in the construction and installation of metallic structures through which they can improve their work and find clear solutions of the problems encountered in their research. This guide should include complete methods for the evaluation and assessment of complex phenomena occurring in physical modeling and mathematical simulation of the interaction between anthropic fields and ecosystems
 - Lightning monitoring network approach comes with its interest in expanding in Romania by LINET Nowcast. The effect of such an extension would manifest greatly enhanced recording with precision the lightning phenomena in the country, with implications particularly valuable in predicting possible failures and faults on transmission lines. Discussions in this regard, went on a favourable trend extending such action.
- Boosting the promotion of the obtained research results in academic field, through reports and papers, and in potentially interested industry fields by oriented presentations, which could later generate funding (HORIZON 2020). It will be tried to strengthen connections with well-known foreign researchers in the area and to promote some collaboration directions. This should raise the international prestige of the TUCN.
- Continuing the existing cooperation the field at national and international level: University of Western Macedonia, Greece (G.C. Christoforidis – 20 papers in collaboration with the author of this thesis); Universita di Padova, Italy (D. Desideri - 10 papers in collaboration with the author of this thesis); UPB (Prof. C. Popescu – collaboration in research projects CEEEx X2C37/2006; prof. D. Gavrilă - CEEEx 6856/2006); ICPE C.A (dr. I. Lingvay – 10 papers in collaboration with the author of this thesis, 4 research projects).