Doctoral Thesis Review Report

Title: Methods of Numerical Inversion of Laplace Transforms for Electrical Engineering and their Applications
Institution: Faculty of Electrical Engineering and Communication, Brno University of Technology, Czech Republic
Author: Nawfal Al-Zubaidi R-Smith
Supervisor: Prof. Ing. Lubomír Brančík, CSc.
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Reviewer: J. A. Tenreiro Machado, Principal Coordinator Professor, Dept. of Electrical Engineering, Institute of Engineering, Polytechnic of Porto, Portugal

Review Report

The document is organized seven chapters, namely:

- Chapter 1, State of the Art
- Chapter 2, Dissertation Objectives
- Chapter 3, 1D Hyperbolic NILT Method
- Chapter 4, Applications of the 1D Hyperbolic NILT Method
- Chapter 5, Expansion of the Hyperbolic NILT Method into the Two-Dimensional Form
- Chapter 6, Applications of NILT Methods in the Field of Electrical Engineering
- Chapter 7, Research Challenges and Conclusions

Besides these chapters we find also Abstract, List of Figures, List of Tables, Introduction, Bibliography, and Lists of abbreviations and appendices. Three appendices include the Curriculum Vitae, List of Publications, and Achievements.

The Doctoral Thesis is written in English and makes a total of 132 pages. The text and formulas seem to be typed in Latex and the charts and programs coded using Matlab. In all cases, the work follows a professional and careful style, the symbols and variables are clearly defined, and the experiments and results well organized and the charts provide a good graphical visualization.

The work is devoted to several aspects of Numerical Inverse Laplace Transforms (NILT) methods, and applications in the area of electrical engineering. Moreover, the research includes also the area of Fractional Calculus (FC).

The work starts with the Introduction (2 pages) describes briefly the scope of the work.

Chapter 1 (19 pages) entitled "State of the Art" is organized in 6 sections and provides an overall view of the different NILT methods, discusses their characteristics, having in mind engineering applications.

Chapter 2 (2 pages) entitled "Dissertation Objectives" is organized in 3 short sections. Here we find the problems and the objectives formulated by the author within his PhD dissertation. We can discuss the inclusion of extra text about the history and development of the area. However, the option of the author seems adequate since presently NILT and FC are known areas and the inclusion of extra descriptions would lead to a lengthy and

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unnecessary long text. On the other hand, the may be joining this chapter with the Introduction would be interesting from the point of view of organization.

The chapter 3 (19 pages) entitled "1D Hyperbolic NILT Method" is organized in 5 sections including Summary. Here the hyperbolic NILT method is introduced and an improved method, relatively universal and with a good accuracy is formulated. The analysis and numerical tests are performed for several examples including transients in lumped and distributed systems.

The chapter 4 (31 pages) entitled "Applications of the 1D Hyperbolic NILT Method" is structured in 8 sections including Summary. In this case we have a long chapter that addresses several important and distinct types of applications with focus in electrical engineering. Moreover, examples based on fractional calculus models are also included. Indeed, we have the analysis of transmission lines, including lossy, frequency-dependent, multi-conductor, and of fractional-order.

The chapter 5 (13 pages) entitled "Expansion of the Hyperbolic NILT Method into the Two-Dimensional Form" is sub-divided into 5 sections including Summary. Here is extended the NILT method for cases involving two variables. Several numerical tests, the analysis of errors, and comparison between alternative approaches are included.

The chapter 6 (8 pages) entitled "Applications of NILT Methods in the Field of Electrical Engineering" is organized in 3 sections including Summary. Here we find challenging and advanced applications, namely the application of the 2D hyperbolic NILT to a lossy TL and the simulation of nonlinear circuits using multidimensional NILT.

Finally, the chapter 7 (4 pages) entitled "Research Challenges and Conclusions" presents the main conclusions of the doctoral thesis and points toward some future recommendations, both for research, implementation and collaborations. Its extension and writing style are adequate. In the reviewer opinion the author could expand (and be more ambitious) in the part about future research directions. On the other hand, to have parsimony in the possible future works is also a quality that the reviewer would like to remark.

There are several comments that the reviewer would like to forward. First, we can discuss if the introduction and the two initial chapters should be joined or re-organized. The reviewer considers that the author's option to be the appropriate both to avoid having the same topic scattered along distant parts of the work and to avoid the multiplication of cross-referencing.

The rest of the chapters have a manageable length and the reader can enjoy the flux of ideas and concepts. The reviewer considers that chapters 4-6 involve relevant contributions. Probably, the review of the literature and the analysis of fractional-order systems could be even more ambitious. Nonetheless, the candidate achieved clearly important results, both for integer and fractional systems and the adopted strategy is solid and realistic.

In summary, the reviewer considers that the author presents a considerable volume of work. Many aspects are novel, and they are discussed assertively and in detail. The symbols and formulas are clearly defined, and the figures and tables are informative. The analysis of the state of the art includes relevant works. Moreover, the text and writing style are fluent, so that readers can follow closely the ideas presented by the author.

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The reviewer believes that the doctoral thesis represents a timely and important contribution to the scientific knowledge in the area. In fact, previously published books and journal papers address limited areas which lead to a lack of engineering tools for studying the proposed systems. The research developed by the candidate tackles several areas that are often considered separately under the umbrellas of mathematical methods, dynamical systems, fractional calculus and computer science. Therefore, algorithmic and computational issues are studied alongside with differential calculus, transforms, and modeling.

As often occurs with solid scientific work, the research avenues opened are always larger that those explored. Therefore, some global questions emerge and their answer is of relevance in a strategic perspective:
- The Fourier transform is often favored in retaliation to the Laplace transform. What were the reasons stimulating the PhD work?
- The application of transforms methods is often "restricted", implicitly, to linear systems. What are the perspectives for adopting the techniques with general classes of non-linear systems?
- What are the reasons underlying the study of electrical systems only, and not including mechanical or other systems?

Bearing these ideas in mind, the reviewer considers that the submitted Doctoral Thesis represents an excellent work that should be accepted. The candidate should be awarded with the title of "Doctor".

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