

# **HABILITATION THESIS**

## **GRAPHICAL PROGRAMMING IN MEDICINE, POWER ELECTRONICS AND MODERN EDUCATION**

### **Abstract**

The present habilitation thesis summarizes my research activity after the PhD thesis was defended in December 1998 at Politehnica University Timisoara. The PhD Thesis was certified by the Ministry of Education and Research, Order no. 3460 / 15. 03. 1999.

According to the regulations, the first part of this habilitation thesis is represented by the English and Romanian versions of the present abstract.

A description of the second part is given below.

An overview of activity, stressing out the most important research, professional and academic achievements: publications list and grants, new courses absorbed in the curricula and contributions to the academic curricula development, taught courses, diploma and dissertation adviser activity, invited professor, students internship, endowed laboratories and library, international cooperation, management activities, etc. The activity can be synthesized by the most important mentioned aspects that are a number of 69 research papers published in the above mentioned period, 23 research grants and 5 books.

In the following paragraphs a technical presentation regarding four main research topics is provided:

➤ **Electromagnetic compatibility** - First a very powerful tool developed by the author for studying the magnetic field of shaped slotted screens is described. The proposed method is based on a circuital characterization of the structure, via the **Finite Element Method (FEM)** which is then combined with a modal expansion to compute the field inside and outside the border. The next chapter is concerned with predicting the electrical behavior of metallisation patterns printed onto dielectric substrates. It involves the generation of an equivalent circuit to model the electrical properties of the layout. This can be efficiently obtained and directly provided to a circuit simulation program. The last chapter presents a new test procedure for measuring the **shielding effectiveness (SE)** of shielded coaxial cables. The **Transverse Electromagnetic (TEM)** modified measurement cell with an asymmetrically placed conductor together with the proposed form of the cell, establish a quasi-uniform field in the zone where the testing cable is placed.

➤ **Graphical programming in biomedical signal and image processing** - The first part of this chapter will describe a computer based signal acquisition, processing and analysis system using **LabVIEW**. Peak detection in electrocardiogram (ECG) is one of the solved problems using **LabVIEW** and filtering biomedical signals in different ways is a challenge that has to be solved. The next topic presented is graphical programming in event detection using Pan-Tompkins algorithm. QRS and ventricular beat detection is a basic procedure for electrocardiogram (ECG) processing and analysis. Further novel compression techniques are developed for portable heart-monitoring equipment that could also form the basis for more intelligent diagnostic systems thanks to the way the compression algorithms depend on signal classification. Then the design of an optimal Wiener filter is implemented to remove noise from a signal, assuming that the signal is statistically stationary and the noise is a stationary random process that is statistically signal independent. Two programs for compression and Wiener optimal filtering are developed in **MATLAB**. Also in this chapter a real-time QRS detection method implemented in **LabVIEW** is proposed, based on

comparison between absolute values of summed differentiated electrocardiograms of one or more ECG leads and an adaptive threshold. Two algorithms were implemented in **LabVIEW**. In the last part a real-time 3D echocardiography and the corresponding algorithms that improve the quality of the image are presented. The second image application concerns the compression and noise removal of mammography images because these realize a preprocessing for the identification of microcalcification clusters in mammograms. A non-linear method is implemented in **LabVIEW** for performing image enhancement. The final chapter reviews ultrasound segmentation methods, in a broad sense, focusing on techniques developed for medical ultrasound images.

➤ **Solar Energy and Power Electronics** - The first chapter introduces the first station in Romania (Eastern Europe) outfitted for systematic monitoring of solar irradiance on tilted surfaces. The resulted database is in many aspects unique for Romania, allowing for the first time to derive specific parameters, like diffuse fraction or sunshine number. The second chapter concerns Power Electronics. It is related to small signal transfer functions (control to output and audiosusceptibility) derivation in quasiresonant converters (QRCs). A matrix method based on state-space averaging of the PWM parent converter and switch cell conversion ratio is proposed. The result is general in the sense that the formalism is converter independent. The method was verified for all classical converters and perfect agreement with other tools was obtained.

➤ **E-learning techniques** - The first part presents a comparison between classical hands-on laboratories and remote laboratories. Even they are very useful, hands-on laboratories have limitations regarding space, time and staff costs. These problems can be significantly alleviated by using remote experiments and remote laboratories when the students operate with real systems, although they are not present in the laboratory. The approach is based on constructivism and neoconstructivism concepts. The second part describes aspects regarding an E-learning approach of resonant ac inverters. The learning process is based on "Learning by Doing" paradigm supported by several learning tools: electronic course materials, interactive simulation, laboratory plants and real experiments accessed by Web Publishing Tools under LabVIEW.

- The main results achieved in the field of Electromagnetic compatibility were published in 19 papers (17 as first author) and also 3 national grants tackled this field. Both 17 publications (16 as first author) and 3 national research grants refer to the field of graphical programming in biomedical signal and image processing. Solar energy and Power electronics is subjected to 13 papers (2 as first author) and 2 national grants, while E-learning teaching techniques have been investigated in 6 papers, 2 international grants and 2 national grants.

- Scientific, professional and academic future development plans. Emphasis will fall both on wavelets in biomedical signal and image processing using graphical programming and on multimedia signal processing including 2D/3D image, video, speech, 2D/3D signal processing issues. Also wavelet transform and applications, time series analysis and stochastic processes will be of concern. As the first steps were already made, it is intended to consolidate the already established cooperation with researchers from "Victor Babeş" University of Medicine and Pharmacy, Gastroenterology Department, regarding automated image analysis and diagnosis.

The third section is dedicated to the references.