Universitatea
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Habilitation Theses

APPLIED RESEARCHS ON MULTIFREQUENCY SIGNAL PARAMETERS ESTIMATION, ANALOG-TO-DIGITAL CONVERTERS DYNAMIC TESTING, AND SYNCHROPHASORS ESTIMATION

Author: Daniel-Cornel BELEGA

Abstract

In the habilitation thesis the main professional and research results achieved during the period 2002 - 2013 are presented. In the aforementioned period the main research fields were: Signal Processing, Analog-to-Digital Converter (ADC) Testing, and Synchrophasor Measurements.

In the Signal Processing the parameter estimation of a sine-wave by the frequency-domain methods - Interpolated Discrete Fourier Transform (IpDFT) method and the Energy-Based (EB) method - and the sine-fitting algorithms is analyzed. The statistical performance of each above frequency-domain method is analyzed. Furthermore, two multipoint IpDFT methods for frequency estimation are described and their performances are compared. Besides, the expression of the combined standard uncertainty of the frequency estimator achieved by the most suited to be used in practice multipoint IpDFT is given. Then, the performance of the average-based IpDFT method is presented. Also, the effectiveness of a multipoint IpDFT method for amplitude estimation as compared with the IpDFT method is revealed. The results of the comparison between the theoretical means of the sum-squared fitting and residual errors achieved by the three-parameter sine-fitting (3PSF) algorithm with frequency a-priori estimated by the IpDFT method (3PSF-IpDFT algorithm) and the four-parameter sine-fitting (4PSF) algorithm are presented.

In ADC Testing is investigated the estimation accuracy of some of the most important dynamic parameters of an ADC, which are the Effective Number Of Bits (ENOB) and SIgnal-to-Noise And Distortion ratio (SINAD), achieved by means of the frequency-domain and time-domain sine-fitting algorithms when the sine-wave test signal is non-coherent sampled. The procedure used to estimate the SINAD and ENOB parameters by a sine-fitting algorithm is given. Then, the expressions for the mean and variance of the ENOB estimates provided by a sine-fitting algorithm are presented.

In Synchrophasor Measurements the synchrophasor estimation achieved by some DFT-based estimators in the case of an electrical signal with decaying dc offset component are presented. The performance of the IpDFT synchrophasor estimator is also presented in the habilitation thesis.

The full abstract at:
http://www.upt.ro/pagina_indep.php?cat=nu_pagini&id=eBbLH

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APPLIED RESEARCH ON HIGH IMPEDANCE SURFACES AND SIGNAL PROCESSING

Author: Aldo DE SABATA

Abstract

This work is mainly focused on research results obtained by the author in the field of Applied Electromagnetics between 2009 and 2013. Signal Processing, which is another research area approached in the past, is also covered.
Activity in the field of Applied Electromagnetics has been directed to (i) applications of Metamaterials with electromagnetic band-gap(s), (ii) calculation of forces in magnetic fluids environment and (iii) education.
The history of Metamaterials is about a decade long. This direction of research has been approached in 2009. Several fixed and switched planar structures with potential applications in filtering and signal integrity have been devised.
Restoring forces in magnetic fluids bearings have been calculated by using several models and approximations in view of validation.
In Signal Processing, work and results can be grouped in two categories (i) spectral analysis and (ii) sampling theory.
The section on Applied Electromagnetics contains a review of the field of metamaterials introduced in order to motivate the framework of the activity. A selection of relevant results in fixed, planar structured surfaces acting like Metamaterials with electromagnetic band-gaps is presented, followed by another subsection containing results on switched surfaces. The second part of the section on Applied Electromagnetics is dedicated to results obtained in calculation of restoring force in magnetic fluid bearings with poles on the stator and on the rotor (shaft). Plane-parallel and plane-meridian models for the magnetic field are used in order to compare the predictions in view of validation of results concerning the evaluation of the restoring force.
In the section concerning Signal Processing, two algorithms that significantly improve the frequency estimation of sinusoids embedded in white Gaussian noise are presented. The algorithms are evaluated in the small sample case and asymptotically and results of computer experiments are reported in order to demonstrate the effectiveness of the proposed methods.
Results in Sampling Theory of multi-dimensional signals are then reviewed. These results are a continuation of the author's doctoral work. The selected signal model consisted of complex, multidimensional, band-limited periodic and finite energy signals sampled along non-orthogonal axes. The author proposed several sampling procedures at the minimum sampling density and the corresponding reconstruction methods. A sampling theorem for band-limited, complex periodic signals is stated and demonstrated. Sampling is performed on non-orthogonal directions. Finite-energy, complex, band-limited signals with spectrums containing gaps have been considered in view of finding sampling procedures at the minimum Shannon-Landau sampling density. Examples in the cases of derivative sampling and delay-systems sampling are provided. The aliasing error is evaluated and aliasing error bounds are reported.
The report is concluded with perspectives on future work in the newly equipped Laboratory of Microwaves, Antennas and Electromagnetic Compatibility.

The ful abstract at:
http://www.upt.ro/pagina_indep.php?cat=nu_pagini&id=eBbLH

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