Project objectives

A new algorithm for time step choice: One starts with theoretical analysis of the algorithms existing in SPICE, SPECTRE and PAN and case studies. Next, the energy computation and the error definitions will be established and a set of new strategies for step choice will be developed. The algorithm will be implemented in SPICE3 sources which are available at the Electrical Engineering Department of the Politehnica University. This implementation will be tested on simple circuits and a comparison with the SPICE and SPECTRE results will be made.
A new algorithm for envelope following: One starts with theoretical analysis of the algorithms existing in SPICE, SPECTRE and PAN and case studies. Next, a new algorithm for jump computation will be developed; and this algorithm will be tested on simple circuits.
A new frequency domain analysis algorithm: One starts with theoretical analysis of the HB and Fourier envelope algorithms. A new algorithm for analysis of circuits with resistive nonlinearities will be developed, based on the ideas dealing with electromagnetic field analysis in nonlinear materials [16]. It is expected that this method will be more efficient than HB for the specified circuit class because the Newton-Raphson iterations of HB are not necessary. This method will be tested on simple examples, the algorithm linking the time domain and frequency domain signal representations being optimized, as well as the algorithm for solving linear algebraical equations.
The efficiency of the proposed methods in mixer analysis The following aspects will be studied: Transient analysis –case studies, EF analysis - case studies, Comparison between TRAN and EF analyses, Frequency domain analysis –case studies, Comparison with HB and Fourier envelope analyses, Comparison between time domain and frequency domain analyses.
The efficiency of the proposed methods in nonlinear amplifier analysis The same aspects as in the previous objective will be studied.
The efficiency of the proposed methods in switched capacitor circuit analysis The same aspects as in the previous objective will be studied.
The conclusions to be drawn following these studies of the efficiency of the proposed algorithms will show the area of the maximum efficiency of these methods in comparison with the most performant known methods.
Estimated impact of the project The research carried out in this project will generate papers published in prestigious journals and in the proceedings of renowned conferences. The young researchers involved will be encouraged to continue their scientific career, becoming even an example for their colleagues. The project creates opportunities for future international cooperation.
The interdisciplinary character is pointed out by the following aspects:
- the project puts together professionals from Electrical Circuit Theory and Electromagnetic Field Theory; the problems to be solved can be placed between those areas and Microelectronic Devices and Circuits. The solving of some complex problems with applications RF circuit analysis, especially in mobile communications, is ensured in this framework.
- using the results and the theory from a field of science in a complementary field (the frequency domain analysis method of the circuits with nonlinear resistors are based on ideas introduced for the electromagnetic field and applied in this project to the electrical circuits).

Methodology of the research

The objectives have been set, firstly, by a critical analysis (both theoretical and case studies) of known algorithms implemented in comercial simulators. Next, the new algorithms will be developed and tested on simple examples. Finally, the algorithms will be implemented in the available sources of some commercial simulators (to take advantage of automated circuit equation formulation and of the existing models libraries) and their efficiency will be tested for three RF circuit categories with significant simulation difficulties: nonlinear amplifiers, mixers and switched capacitor circuits.
The solutions considered in order to reach the objectives in view are not exposed to risks except the implementation of the new time step choice algorithm in SPICE3 source code. There is a risk in this activity realization related to the incomplete available information about the SPICE3 source code. New time step choice algorithm can be evaluated without this kind of implemetation, using circuit test software, elaborated by the research team members.