Secondment Report Form

Secondee	**ZVONIMIR SIPUS**
Host Organization	Id: **12**
	Name: **Ecole Polytechnique Federale de Lausanne (EPFL), Lausanne, Switzerland**
Research Topic(s)	**Electromagnetic theory and numerical techniques**
	Acceleration of slowly converging series
	Antenna analysis

ACTIVITIES DURING THE SECONDMENT

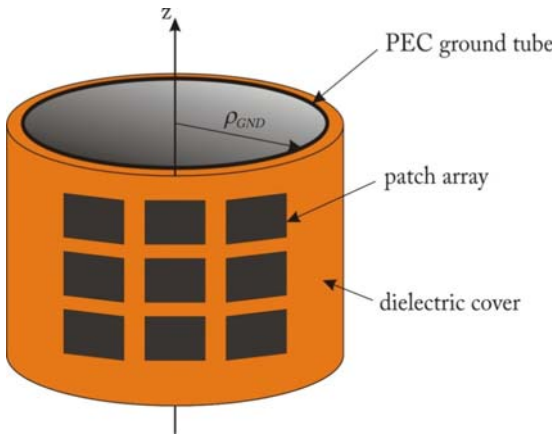
One of the most popular analysis methods for curved antennas and periodic structures is the spectral-domain method, which combined with Method of Moments is applicable to a wide range of multilayered problems with a canonical geometry. Numerous benefits come as a consequence of this transformation, but unfortunately also several difficulties, of which two are usually most time consuming. The first are highly oscillating integrals which are encountered when the source and observation points are separated in the direction for which the structure is planar (e.g. in axial direction for cylindrical case). The second problem of the spectral-domain method lies in the summation of a large number of terms in the sums which need to be evaluated in this approach. While the problem of evaluating the oscillating integrals has been extensively investigated in the scientific literature, the summation problem has been discussed only by a few authors.

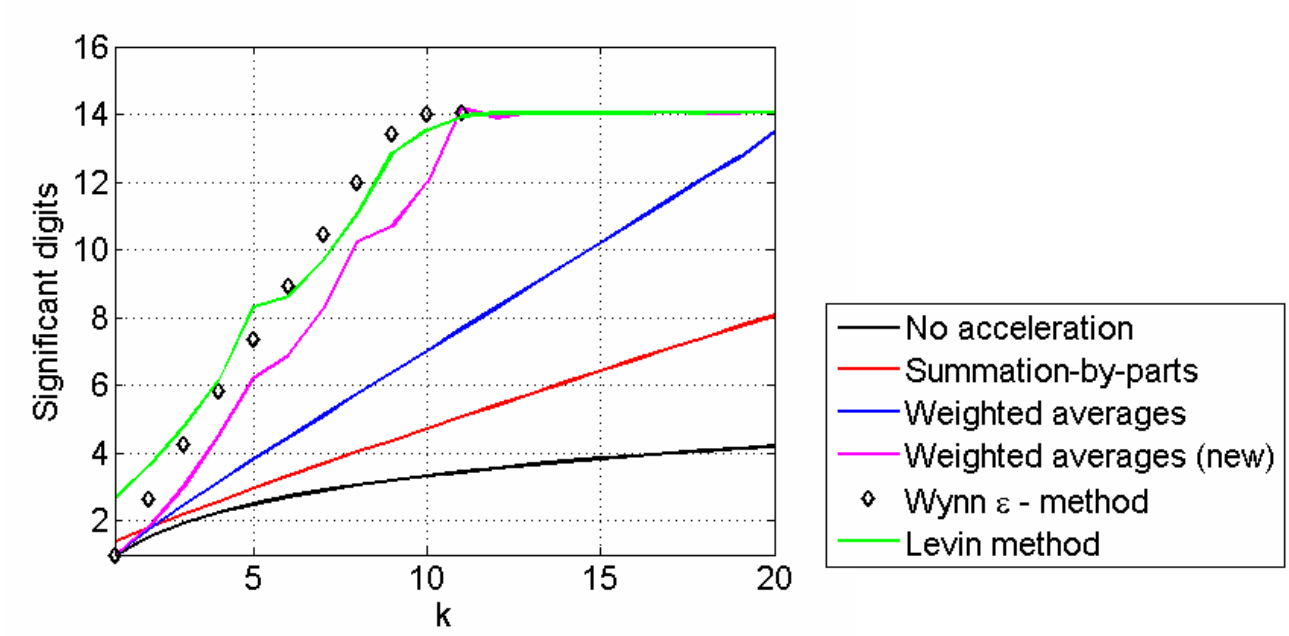
The acceleration techniques for series have attracted a lot of interest when determining electromagnetic field distribution inside a resonant box or when analyzing planar frequency selective surfaces (FSS). The purpose of the performed research was to investigate if it is possible to use this knowledge and experience to accelerate the series summations appearing in the analysis of curved antennas and FSS. The results show that some methods, like the Wynn's series acceleration algorithm, are suitable for direct implementation in the series acceleration. However, other methods, like the weighted averages algorithm and the θ-algorithm can be implemented only to the local extremes of the partial sums. The accuracy of the proposed methods will naturally depend on the radius of curvature and on the distance between the source and the observation points. Therefore, the purpose of the performed work was to investigate accuracy of the known acceleration methods and eventually to develop some new method, which would results in a fast and accurate program for analyzing conformal antennas.

The research performed at EPFL resulted with an efficient method for analysis of conformal electromagnetic structures based on the application of the Summation-by-Parts algorithm and of the Wynn's ε series acceleration algorithm within a spectral domain – MoM algorithm. The accuracy of the developed method depends on the radius of curvature and on the distance between the source and the observation points. The results have shown that better accuracy is obtained for larger radii and larger separations between the source and the observation points. This is counterintuitive since in the non-accelerated spectral-domain method the number of needed terms grows when the structure or separation is increased. However, this property makes this method very valuable since now it is possible to develop efficient programs for analyzing very large curved antennas and frequency

selective surfaces, i.e. where the overall computation time and required memory resources will be significantly reduced.

As an example, let us consider a cylindrical antenna structure as in the figure. The working frequency is 4 GHz, the radius of the structure is 2 wavelengths, and the patches are printed at the substrate of permittivity 2.33 and thickness 0.787 mm. Several acceleration methods are compared by calculating the G_{zz} component of the dyadic Green's function. The results are shown on figure below. It can be seen that the best results are obtained with the weighted-average method, with the Wynn ε method, with the summation-by-parts method and with the Levin method.





MAIN RESULTS OF THE STAY

< List of the publications co-written (or in progress)>

Number of Publications: __2 (in progress)_____

Number of Documents/ Reports: _1 (in progress)

Number of Case Studies & Demonstrators: __-___

Other(s):

(1) __Start of cooperation in connection with new acceleration methods___

(2)_____

(3)_____

* Attach all relevant documentation that specifies your results

FORECAST ACTIVITIES

<Are there any envisaged activities following this secondment project, new collaborations, co directed PhD, etc>

The newly started cooperation will include:
(1) common research on the accuracy of the acceleration methods and on developing modifications of the existing methods that will be suitable for problems appearing in the conformal antenna analysis.
(2) two conference papers in future (one of them will be presented at the INTELECT 2012 workshop, one of them at some general conference in 2013)
(3) exchange of master and Ph.D. students.

In order to improve CARE's secondment program, please fill this short questionnaire. Use the space at the end to expand your answers, if needed. Our aim is to improve the general experience for secondees in future.

Disagree ➢ ➢ Agree

GENERAL				
My objectives were achieved.	**1**	**2**	**3**	**4 X**
The research topics were relevant to my work.	**1**	**2**	**3**	**4 X**
I benefited from being part of a wider research culture.	**1**	**2**	**3**	**4 X**

HOST ORGANIZATION				
I am satisfied with the quality and quantity of supervision I received.	**1**	**2**	**3**	**4 X**
I had access to adequate resources to support my research..	**1**	**2**	**3**	**4 X**

SECONDMENT PROGRAM				
I would recommend this secondment programme to others.	**1**	**2**	**3**	**4 X**
I believe the skills I have learned will help me to improve my job/research.	**1**	**2**	**3**	**4 X**
I would apply to another programme similar to CARE.	**1**	**2**	**3 X**	**4**
In general, how would you classify the CARE Secondment Programme?	**1**	**2**	**3**	**4 X**

Other questions/comments to be potentially considered: _____

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SIGNATURES

Candidate **Zvonimir Sipus** **Date**: 2012/03/19 (year/month/day)

Signature