Re: Array design with Meep simulation scripts

g.l. gragnani <gianluigi.gragnani@unige.it>

Tue 2/23/2021 12:44 AM

To: Hanson, Jordan <jhanson2@whittier.edu>; Alessandro Fedeli <alessandro.fedeli@unige.it>

Dear Jordan,

once again, your code works very well. As for the evaluation of S11, we cannot provide any insight, at least for Meep. You could check how GprMax or OpenEMS work.
In our opinion the starting point could be simply to compute I and V at the feeding gap, by means of the integration capabilities of Meep and further try to implement more elaborated feeding ports. Perhaps, the simulation of a single antenna in 3D could provide results more simple to analyze.

There are some old, yet very interesting papers, about the modelling of lumped elements and "soft" generators in FDTD code.

V. A. Thomas, M. E. Jones, M. Piket-May, A. Taflove and E. Harrigan, "The use of SPICE lumped circuits as sub-grid models for FDTD analysis," in *IEEE Microwave and Guided Wave Letters*, vol. 4, no. 5, pp. 141-143, May 1994, doi: 10.1109/75.289516.
R. J. Luebbers and H. S. Langdon, "A simple feed model that reduces time steps needed for FDTD antenna and microstrip calculations," in *IEEE Transactions on Antennas and Propagation*, vol. 44, no. 7, pp. 1000-1005, July 1996, doi: 10.1109/8.504308.
Mix, J., Dixon, J., Popovic, Z. and Piket-May, M. (1999), Incorporating non-linear lumped elements in FDTD: the equivalent source method. Int. J. Numer. Model., 12: 157-170. https://doi.org/10.1002/(SICI)1099-1204(199901/04)12:1/2<157::AID-JNM323>3.0.CO;2-V

We also found an MS thesis at this link https://ttu-ir.tdl.org/bitstream/handle/2346/12301/31295019601334.pdf?sequence=1

Best regards.

Alessandro and Gian Luigi

On 2/20/21 7:48 PM, Hanson, Jordan wrote:

> Dear Alessandro and Gian Luigi,
> Glad to hear the code is working well. My reply is delayed since we were administering final exams here (our classes now conclude each quarter due to a change from the pandemic). Since the code in my previous message is understandable, I've attached one that is more complicated: the one-dimensional array of horn antennas. In this version, the frequency can be varied over a wider range. Please let me know if you can produce reasonable outputs with it. One thing I was hoping to learn from you is how to connect a 50 Ohm cable to one antenna modelled in this type of code, and calculate the VSWR or S11 parameter. I can imagine a way to do it, by measuring how much energy flows out the antenna and how much energy flows back along the cable. However, this sounds complicated. Perhaps you each have some insight.
> Good luck and best regards,

Jordan Hanson
Whittier College

From: g.l. gragnani <gianluigi.gragnani@unige.it>
Sent: Monday, February 15, 2021 11:42 PM
To: Hanson, Jordan <jhanson2@whittier.edu>
Cc: Alessandro Fedeli <alessandro.fedeli@unige.it>
Subject: Re: Array design with Meep simulation scripts

Dear Jordan,
thank you very much for your prompt reply.
Your script is working like a charm, and is a very good starting point to learn Meep.
Collaborating is a great idea. We are mostly interested in 3D modelling for antennas and RF devices.
We look forward to hearing from you.
Best regards.
Alessandro and Gian Luigi.

On 2/13/21 11:10 PM, Hanson, Jordan wrote:

> Dear Alessandro and Gian Luigi,
> It's exciting to hear from you. At the beginning of last summer, I read your review article about open-source antenna modeling (Electronics 2019, 8, 1506; doi:10.3390/electronics8121506). I was searching for a way to model phased arrays while avoiding proprietary software, and your excellent paper showed me that it can be done. Separately, I heard about Meep from a colleague who modelled RF propagation in ice. I noticed in your paper that Meep (and other codes) was mentioned but that the analysis focused on gprMax, openEMS, and NEC2. This is reasonable since packages like Meep are stranger to implement. Based on one example I found in https://meep.readthedocs.io/en/latest/, I was able to calculate radiation patterns. The next step is to work on S-parameters (S11). I have attached a simple example, written in Python3, for a N=16 one-dimensional array of Yagi antennas with uniform index of refraction in two-dimensional space. Please let me know if you can get it to run. Would you be interested in collaborating in the future? We could figure out how to use the parallel features of Meep and how to perform the S-parameter calculations.
> Best Regards,
> Jordan Hanson
>
> MEEP Documentation
> Meep is a free and open-source software package for electromagnetics simulation via the finite-difference time-domain (FDTD) method spanning a broad range of applications.. Key Features. Free and open-source software under the GNU GPL.; Complete scriptability via Python, Scheme, or C++ APIs.; Simulation in 1d, 2d, 3d, and cylindrical coordinates.; Distributed memory parallelism on any system ...
> meep.readthedocs.io

From: g.l. gragnani <gianluigi.gragnani@unige.it>
Sent: Saturday, February 13, 2021 1:43 AM
To: Hanson, Jordan <jhanson2@whittier.edu>
Cc: Alessandro Fedeli <alessandro.fedeli@unige.it>
Subject: Array design with Meep simulation scripts

Dear Prof Hanson,
we have read your very interesting paper "Broadband RF Phased Array Design with MEEP: Comparisons to Array Theory in Two and Three Dimensions", recently appeared on Electronics.
As you know open-source software for electromagnetics is among our research interests. We would like to kindly ask you whether it is possible to obtain some of the simulation scripts as mentioned in the paper.
Thank you very much in advance.
Best regards.
Alessandro Fedeli
Gian Luigi Gragnani

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