Comprehensive Electromagnetic Solutions

FEKO

QUARTERLY: March 2008

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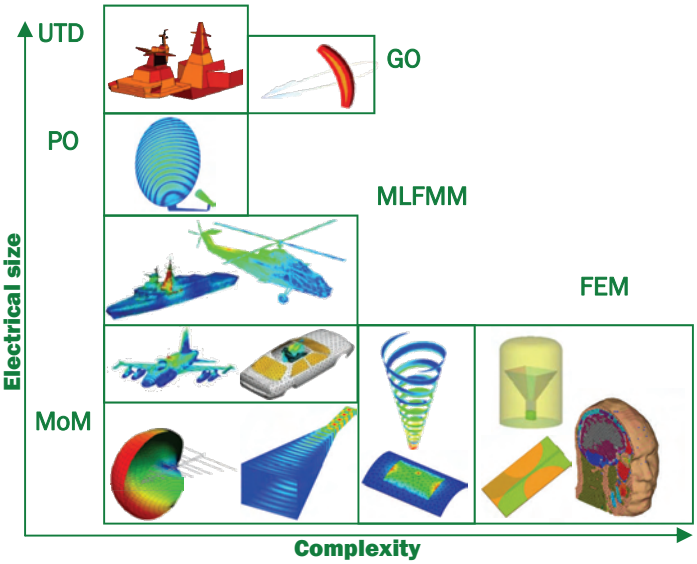
FEKO provides a growing list of numerical techniques to enable our customers to solve almost any electromagnetic analysis problem with the appropriate technique. Selecting an appropriate technique can become a daunting task, so this issue of the FEKO Quarterly presents some guidelines to help our users select the right technique for their problems. As always, your comments on the quarterly are welcome. If you would like to contribute an article, please send it to *quarterly@emss.co.za*.

How to Choose an Appropriate Simulation Technique

Electromagnetic simulation techniques have increased in complexity and number with FEKO providing several of these techniques for problem solution. Each technique has a specific type of application that it works best for, or that it was designed for. This article provides guidelines to help FEKO users choose the appropriate technique for any given problem.

The following solution techniques are available in FEKO:

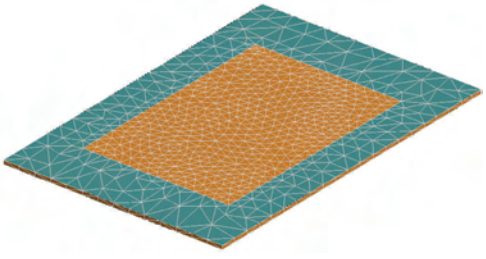
1. Method of Moments (MoM), which has been extended for use with finite dielectric objects using surface meshing, i.e. Surface Equivalence Principle (SEP), infinite planar dielectrics (Green's functions) and finite dielectric objects using cuboids, i.e. Volume Equivalence Principle (VEP). FEKO includes the MLFMM as fast solution method, based on the MoM.
2. Finite Element Method hybridised with MoM (FEM/MoM).
3. Physical Optics hybridised with MoM (PO/MoM).



FEKO numerical techniques - Electrical size vs problem complexity.

4. Geometrical Optics for dielectrics hybridised with MoM (dielectric GO/MoM).
5. Uniform Theory of Diffraction hybridised with MoM (UTD/MoM).

A general rule of thumb is that full wave techniques such as MoM and FEM/MoM are more applicable as the problem grows in dielectric complexity. The full wave MLFMM is applicable to metallic problems of large electric size, but with increasing electric size approximation techniques such as the PO, GO for dielectrics or UTD have to be considered. The following paragraphs highlight specific examples of where the different techniques may be applied effectively.



MoM with SEP — Microstrip antenna with

MoM with SEP

This method is usually chosen for finite sized dielectrics. An example where the MoM / SEP is most effective is the modelling of a finite sized dielectric substrate for a microstrip patch antenna or feed network.

MoM with infinite planar dielectrics (Green's functions)

This method is the optimal technique for the modelling of planar multilayer substrates. While it is computationally efficient, users should keep in mind that the substrate is modelled as infinite in size. Examples where this technique may be applied include a microstrip or stripline feed network and a proximity coupled stacked microstrip patch antenna.

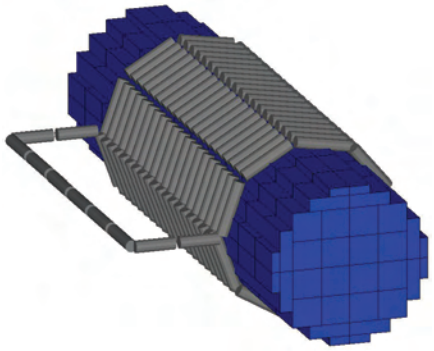
How to Choose an Appropriate Simulation Technique... (2)

MoM with infinite planar dielectrics — Microstrip or stripline feed network.

MoM for finite dielectrics using cuboids (VEP)

This technique should be chosen for electrically small problems (fractions of a wavelength) and where very high permittivity or permeability are modelled. A good example would be a ferrite core with a wire wound around it.

"The MLFMM is applicable to electrically large problems. It is a full wave technique and requires little experience to use effectively. "



MoM for finite dielectrics using cuboids with VEP — Wire around ferrite core.

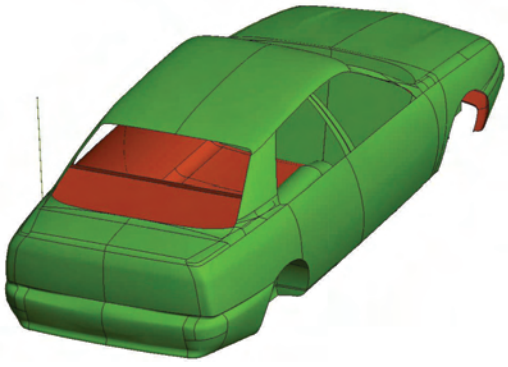
FEM / MoM hybridisation

Models that include inhomogeneous dielectrics are good candidates for FEM/MoM modelling. Examples include human phantoms in radiation exposure studies or stacked microstrip patches with several dielectric layers.

MLFMM

The MLFMM is applicable to electrically large problems. It is an alternative solution method for the MoM full wave formulation and requires little experience to use efficiently. Metallic or low permittivity dielectric problems more than a few wavelengths in size are candidates for the MLFMM solution technique, but not at low frequencies where the MLFMM becomes inefficient. Examples include ships of over 100m length at 100 MHz or a car at > 1 GHz.

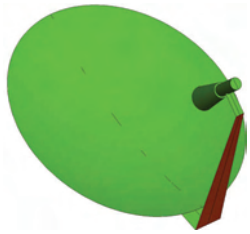
"Start with a full wave technique to obtain higher accuracy from the solution process."



MLFMM — Electrically large metallic structures.

PO hybridised with MoM

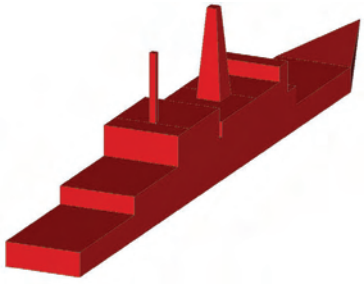
PO is a high frequency approximation technique that is typically used when computational resource requirements for the MLFMM are too large, but were the number of triangles are still within practical limits (~5 million). Examples of PO use include the RCS of a ship of 100m at 500 MHz or a reflector antenna modelled with a far field point source.



PO with MoM - Radiation patterns of satellite dish.

UTD / MoM hybridisation

The UTD is a high frequency approximation technique that is used when computational resource requirements and the number of triangles become excessively large (triangles > 10 million) to solve with the MLFMM or PO/MoM. Examples include radar antenna placement on ships.



UTD hybridised with MoM - Extremely large metallic structures with radiating elements.

GO for dielectrics

GO is used for huge dielectric problems where the excitation is external to the dielectric. An example of such a problem is a lens antenna, modelled with a far field point source as excitation.

Conclusions and rules of thumb

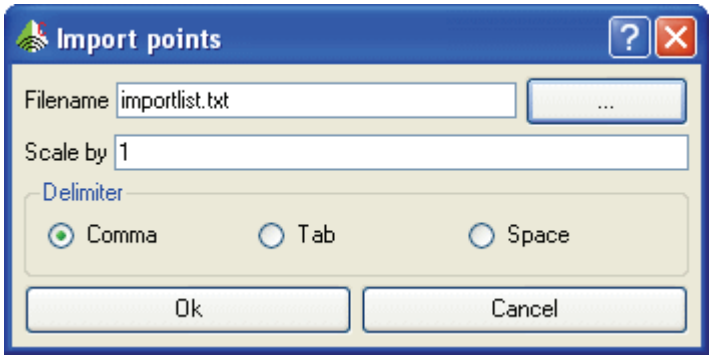
It may not always be clear from the outset which technique to use. Users can base their decisions on solution speed, memory usage, accuracy, model setup complexity or application type.

Start with a full wave technique to obtain higher accuracy from the solution process, but if memory usage is a key issue or models are larger than a few wavelengths, choose the MLFMM, PO, GO or UTD methods. For dielectrically complex problems Green's functions or FEM/MoM are the optimal solution methods. Although PO, GO and UTD are approximation techniques, results that are as accurate as full wave solutions can be achieved if they are used carefully.

Users who remain unsure about which technique to use before starting a new project should email their support team for free advice.

CADFEKO Feature Highlight: Import Points and Batch Meshing

Several simple, but very handy, features are available in FEKO. In order to help improve the experience of users, this article aims to highlight the use of point list imports and batch meshing.



Import Points

FEKO 5.3 introduced the possibility to specify polylines, planar polygons and fitted splines by importing a list of points that were created with a third party application, e.g. Matlab or Excel. This is a very useful tool as users are enabled to design such curves or surfaces in any tool, export the points that define their designs and import them into CADFEKO for simple model construction. The coordinates can be imported in one of three formats: Comma delimited, Tab delimited or Space delimited. Look for the "Import points" button on the polyline, polygon, fitted spline and CableMod dialogs to start the importing process.

Batch Meshing

In some cases it may be necessary to include FEKO in a tool chain consisting of third party software or applications that control a design process or a large, complex set of simulations. This application of FEKO may require that model geometry and meshing be modified for each instance of the simulation. FEKO caters for such simulations with the batch version of CADFEKO called *CADFEKO_BATCH*. CADFEKO_BATCH allows the user to run a simulation from a command prompt, changing model variable values and remeshing the model, all in a single command.

Apart from integration in a tool chain, CADFEKO_BATCH is also very useful when large models have to be simulated or meshed on a platform with limited computational resources. CADFEKO uses some memory for it's own operation and large amounts of memory for the rendering of meshes with many elements. The ability to mesh a model and edit variable values from a command line interface free the resources that CADFEKO would normally use, greatly simplifying the changing, meshing and simulation of large models.

"CADFEKO_BATCH allows the user to run a simulation from a command prompt, changing model variable definitions and remeshing the model, all in a single command."

An example of batch meshing command line use:

```
cadfeko_batch myfile -#a=90 -#r=0.5 -#tL0=0.01 -#l=2
runfeko myfile
pause
cadfeko_batch myfile -#a=30 -#r=1.0 -#tL0=0.2 -#l=3
runfeko myfile
```

Finding Content on the FEKO Website

The new FEKO website was released along with FEKO 5.3 and has been a great success. The new website did not only show off a new look and feel, but also features a complete rethink of how information is handled. The FEKO website is now managed by a Content Management System (CMS), which means information can now be accessed in a multitude of ways from anywhere in the site. The most common ways of finding and organising information with this new system are:

- Browsing in a top-down fashion from the top level site, getting progressively more focussed on a specific topic.
- Searching for specific topics.

Browsing in top-down fashion

Although the title of this technique is self-explanatory, users should note the "small print" at the top right of main pages in the Industries, Applications and Product Info sections. A link titled "Related content" is placed in the top-right of major pages and links to a list of all content on the site that is related to this specific topic.

Searching for specific content

Specific content can be accessed via the search box in the top right of the FEKO web interface. All types of content can be found in this way, including application notes, quarterlies, examples, etc.

Value adding content, e.g. FEKO model files, are reserved for M&S paying users, so users should log in to the site when browsing for information.

"Value adding content, e.g. FEKO model files, are reserved for users only, so users should log in to the site when browsing for information."

Japanese FEKO Users Meeting

The third Japanese FEKO users meeting was held in Tokyo during December 2007. Such user meetings have proved to be very constructive events all over the world and the Japanese users meeting was no exception. 47 representative from various companies attended the meeting. These participants represented various automotive industry users and component manufacturers from related industries.

Attendees at the Japanese Users Meeting

Work sessions on the general use of FEKO and forthcoming features of FEKO were presented by Mr. Van Rooyen and Dr. Jaköbus from the FEKO support and engineering teams in South Africa. Technical information on the theory and application of the MLFMM technique was presented by Prof. Yamada and Mr. Michishita from the Japanese National Defence Academy. Farad Corporation (Japanese distributors for FEKO) believes that a Japanese FEKO users meeting is a good opportunity for their customers to interact with each other and with FEKO's development team and plans to host another user meeting in the coming year.

Exhibitions

FEKO will be exhibited at many conferences this quarter, including the following:

4 April	FEKO International User meeting, ACES 2008, Hilton Fallsview, Niagara Falls, Canada
19 - 23 May	Asia-Pacific EMC Week 2008, Singapore

FEKO Distributors Appointed in India

FEKO is sold all over the world with the customer base in India a rapidly expanding part of the customer base. As such it has become increasingly important that distributors are appointed there to improve relations with customers. This requirement recently lead to the appointment of NI2 Designs as sole distributors of FEKO in India.

NI2 Designs has been a leading distributor of EDA tools and technology in India and aims to diversify their product range with the addition of FEKO. As distributors of FEKO, NI2 Designs will be responsible for promotion, sales and support of FEKO in India. To ensure that they can serve their customers with detailed knowledge of FEKO, NI2 personnel will be visiting South Africa in March 2008 for training in the underlying technologies of FEKO, license types, licensing mechanisms and marketing methods.

The partnership between FEKO and NI2 Designs is sure to be beneficial to both parties, but more importantly to the EM community in India. All current and potential customers in India are invited to contact NI2 to discuss any questions that they might have about FEKO.

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