AN OVERVIEW OF SOFTWARE USED IN ENVIRONMENTAL PROTECTION RESEARCHES

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Abstract
Using software is mandatory in today researches of any field; in the mean time the variety of provided software became more difficult to know, search and pickup; the domain threaten to develop a new specialty: software consultant with unique role to determine the more appropriate software solution for a problem (including costs and other restrictions); the purpose of the present paper is to collect and point by the most relevant Magnetic, Electric and Thermal fields Analysis and Simulations Tools software, used in the field of Environmental Protection Researches;

Key words: software tools, researches, environmental protection

INTRODUCTION

The software used in the field of Environmental Protection Researches is developed in 3 directions:
A. Magnetic, electric and thermal fields analysis and simulations tools
B. Geographical Information Systems
C. Statistical analysis of experimental data
In addition, the environmental researchers, like any researcher, has need of:
D. Software for the meta-analytic review of research literatures.
Due to the complexity of domains and the great number of software
packages in this paper will be presented only the first category.

Magnetic, electric and thermal fields analysis and simulations tools are used more often at the level of processing equipment, like the forestry exploitations, wood processing and food processing equipment;
Classifications:
C1. From mathematical point of view:
They are some different Numerical techniques/ Methods from mathematical point of view which approaches the domain for the PDEs (Partial Differential Equation):
- FEM Finite Element Method (FEA Finite Domain Analysis)
- FDM Finite Difference Method, which is slower than FEM [Zhao H. et al., 1998]
- FDTD Finite Difference Time Domain

- BEM Boundary Element Method
- FVM Finite Volume Method
- FVTD Finite Volume Time Domain
- VIM Volume Integral Method;
C2. Form commercial and accessibility point of view:
They are Free and Proprietary/Commercial packages;
C3. From direct accessibility point of view they have online use modules.

MATERIAL AND METHODS

Selection of software package:
In selection was used the manually search combined with a technique called the Ancestry Approach or Descendancy Approach; this techniques use the references of articles located [Cooper H., 1982]; doctoral dissertations were included especially in this study, as a criteria of novelty;

Evaluation criteria:
- numerical techniques used
- the disponibility (commercial or free)
- the direct disponibility: online use
Indirect criteria: the tool was chosen by some researcher from Environmental Protection Faculty of University of Oradea;

RESULTS AND DISCUSSION

We find 4 doctoral thesis developed between 2007-2012, 1 book and 2 papers which uses the above 6 software tools below;
The most used Commercial packages in FEM Method are:

MATLAB® (from **Mat**rix **Lab**oratory)
MatLab is an interactive development environment for technical computation and related graphics; it uses the programming language of the same name and was created by MathWorks Inc. [10]. MATLAB is a tool for numerical computations with matrices and vectors and integrates visualization and programming. It can interact with other applications and has intuitive graphical interface. MatLab is used extensively in industry and universities and can be used on almost all platforms: Windows, GNU/Linux, UNIX and Mac OS.
MatLab has more specialized functions Libraries, named ToolBoxes (A List of them at [9]). Thus, there are ToolBoxes that allow him to interact with symbolic computation engine like Maple or to solve problems of automatic

control theory, statistical, signal processing, simulation of dynamic systems, neural systems identification etc.

Statistics ToolBox contains: Probability Distributions, chi-square, Poisson etc., Regression, Multivariate Data Analysis, Exploratory Data Analysis, Hypothesis Tests [Ghinea M., V. Firețeanu, 1998].

Bioinformatics ToolBox provide access to genomic and proteomic data formats, analysis techniques and specialized visualizations for genomic and proteomic sequence, microarray analysis etc.;

PDE ToolBox solves partial differential equations using finite element methods [MathWorks, 1984-1997].

Fig.1 Matlab logo.gif

SimuLink® (MathWorks)

An additional well-known package of Matlab, Simulink, provides the opportunity to realize modeling and simulation of dynamic systems using mathematical models. The mathematical model of a dynamic system is the representation of dependence of components. If the model corresponds to a physical process then it is a systematic model, for which exist causal relationships between quantities. SimuLink is a simulator that has graphical user interfaces in which models are presented as blocks and can be manipulated via drag and drop technique, which significantly simplifies programming [Iliescu S., 2005]. Simulink is suitable (more often) for designing controllers like PID (Proportional-Integral-Derivative) or Model Predictive Controllers.

Flux 2D/3D® (www.cedrat.com, France)

FLUX is a finite element software application, having a user friendly interface, and featuring Electromagnetic and thermal simulations, like Design and optimization.

Flux is suitable for Magnetic, electric and thermal fields, Static, harmonic and transient analysis, Parameterized analysis, Magnetic/ dielectric/ thermal coupling, External circuit connections, Mechanical coupling, Multiphysics coupling. It includes a Flux/SimuLink coupling module [Cedrat, 1998].

Applications: Rotating machines, Linear actuators, Induction heating devices, Transformers&inductances, Sensors, High voltage devices, Cables, Electromagnetic compatibility, Non destructive testing.

It accept CAD specifications as start data Flux parametric, has mesh capabilities, analyze capabilities, has a fast& robust solver, post-processing capabilities and CAD exports; A Trial is provided by magsoft-flux.com [11].
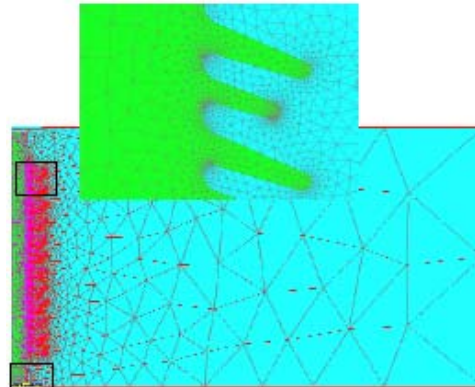
Comsol Multiphysics® (www.comsol.com, USA)

COMSOL Multiphysics (once FEMLAB) is a finite element analysis, solver and Simulation software/ FEA Software package. It can be used for various physics and engineering applications, at high frequencies, especially multiphysics or coupled phenomena (less mass field).

It has a large number of modules like: conventional physics-based user interfaces, toolboxes for a large variety of programming, preprocessing and postprocessing possibilities and an extensive interface to MATLAB. It includes coupled systems of partial differential equations (PDEs). The PDEs can be entered both directly or weak form. Like others The packages are cross-platform (Windows, Mac, Linux) [Comsol, 2008].

HFSS® (**H**igh **F**requency **S**tructure **S**imulator)

HFSS is a finite element method solver for electromagnetic structures from Ansys Corporation [13]. It is used more often for antenna and complex RF electronic circuit elements design, including high frequency and high speed component design. Solver technologies: Frequency domain, Transient solver, Integral Equation, Hybrid finite element- integral Equation Method and Physical Optics.

A list of other FEM software packages we can find at [14].

The most used Free/Open packages in FEM Method are:

FreeFEM (GPL License- France)

FreeFEM is a Finite element method solver for Partial differential equations (PDEs) who include own high level programming language. It solves PDEs in two or three dimensions of space, numerically, using a large variety of finite elements, discontinuous elements included. FreeFEM is the most powerful FEM solver distributed under GPL License [15].

It was released between 1992-2012 4 variants: FreFEM++ v3.2 , FreeFEM3D [16], FreeFEM+(1996) and FreeFEM (1992); previously worked on Macintosh under the name MacFem.

Is has online use too: the FFW interface (FreeFEM on the Web) at [17] (not working at the last moment of testing, 28.10.2012).

At the development of this tool contributed the romaine Ionut Danaila, Laboratories Jacques-Louis Lions, University Pierre et Marie Curie; he has part to the 4 Workshops 'FreeFem workshop on Generic Solver for PDEs: FreeFem++ and Applications', 2009- 2012, Paris, Jussieu [18], which had objectives like 'FreeFEm++ and quantized vortices in fast-rotating Bose-Einstein condensates' (2010) or 'Sobolev Gradients' (2011). Other Free PDE Solvers at opennovation.org [19].
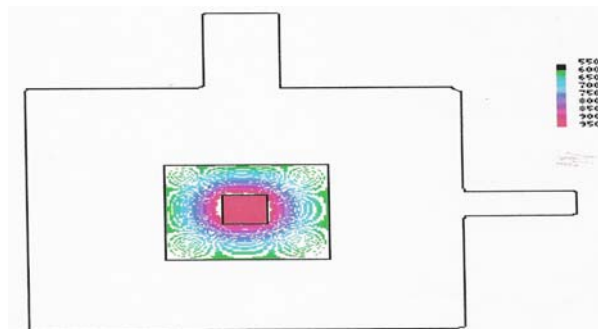

Fig. 3 Uses of MacGFEM at Thermal modeling [Popovici O., D. Popovici, 2008]

CONCLUSIONS

As we see in Table 1, despite the economic challenges, the most popular modeling software tool in the field of Magnetic, electric and thermal fields analysis and simulations are known and used;

Table 1

The use of modeling software tools at The Environmental Protection Faculty, University of Oradea, Romania

Name	Main Numeric technique	Owner	Online use
Matlab (2 uses)	FEM	MathWorks	
SimuLink (2)	FEM	MathWorks	
Flux 2/3D (2)	FEM	Cedrat (France), G2ELab co-development	
Comsol Multiphysics (1)	FEM	Comsol (France)	
HFSS	FEM	Ansys Corporation	
FreeFEM (1)	FEM	Free (GPL License- France)	+

Regarding the mathematical paradigm used for solvers, the most frequent is used the Finite Element Method, then follows The Finite Difference Time Domain, Finite Difference Method and others. It is important to emphasize that a significant number of calculations still must be programmed by engineer/ researcher in various languages (such the interfaces).

Finally, we note the absence (perhaps temporary) of online modules/ cloud computing at the commercial modeling software tools.

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