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E^2GPR - *Edit your geometry, Execute GprMax2D and Plot the Results!*

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In order to predict correctly the Ground Penetrating Radar (GPR) response from a particular scenario, Maxwell's equations have to be solved, subject to the physical and geometrical properties of the considered problem and to its initial conditions. Several techniques have been developed in computational electromagnetics, for the solution of Maxwell's equations. These methods can be classified into two main categories: differential and integral equation solvers, which can be implemented in the time or spectral domain. All of the different methods present compromises between computational efficiency, stability, and the ability to model complex geometries. The Finite-Difference Time-Domain (FDTD) technique has several advantages over alternative approaches: it has inherent simplicity, efficiency and conditional stability; it is suitable to treat impulsive behavior of the electromagnetic field and can provide either ultra-wideband temporal waveforms or the sinusoidal steady-state response at any frequency within the excitation spectrum; it is accurate and highly versatile; and it has become a mature and well-researched technique. Moreover, the FDTD technique is suitable to be executed on parallel-processing CPU-based computers and to exploit the modern computer visualisation capabilities.

GprMax [1] is a very well-known and largely validated FDTD software tool, implemented by A. Giannopoulos and available for free public download on www.gprmax.com, together with examples and a detailled user guide. The tool includes two electromagnetic wave simulators, GprMax2D and GprMax3D, for the full-wave simulation of two-dimensional and three-dimensional GPR models. In GprMax, everything can be done with the aid of simple commands that are used to define the model parameters and results to be calculated. These commands need to be entered in a simple ASCII text file. GprMax output files can be stored in ASCII or binary format. The software is provided with MATLAB functions, which can be employed to import synthetic data created by GprMax using the binary-format option into MATLAB, in order to be processed and/or visualized. Further MATLAB procedures for the visualization of GprMax synthetic data have been developed within the COST Action TU1208 [2] and are available for free public download on www.GPRadar.eu. The current version of GprMax3D is compiled with OpenMP, supporting multi-platform shared memory multiprocessing which allows GprMax3D to take advantage of multiple cores/CPUs. GprMax2D, instead, exploits a single core when executed.

E^2GPR is a new software tool, available free of charge for both academic and commercial use, conceived to: 1) assist in the creation, modification and analysis of GprMax2D models, through a Computer-Aided Design (CAD) system; 2) allow parallel and/or distributed computing with GprMax2D, on a network of computers; 3) automatically plot A-scans and B-scans generated by GprMax2D. The CAD and plotter parts of the tool are implemented in Java and can run on any Java Virtual Machine (JVM) regardless of computer architecture. The part of the tool devoted to supporting parallel and/or distributed computing, instead, requires the set up of a Web-Service (on a server emulator or server); in fact, it is currently configured only for Windows Server and Internet Information Services (IIS). In this work, E^2GPR is presented and examples are provided which demonstrate its use. The tool can be currently obtained by contacting the authors. It will soon be possible to download it from www.GPRadar.eu.

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References

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