An open source electromagnetic simulator for generating big data for Ground Penetrating Radar applications

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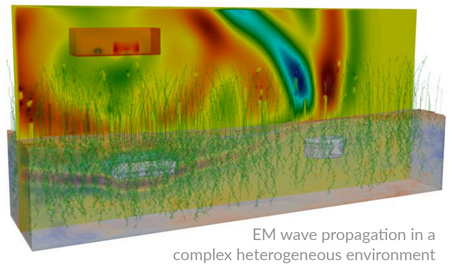
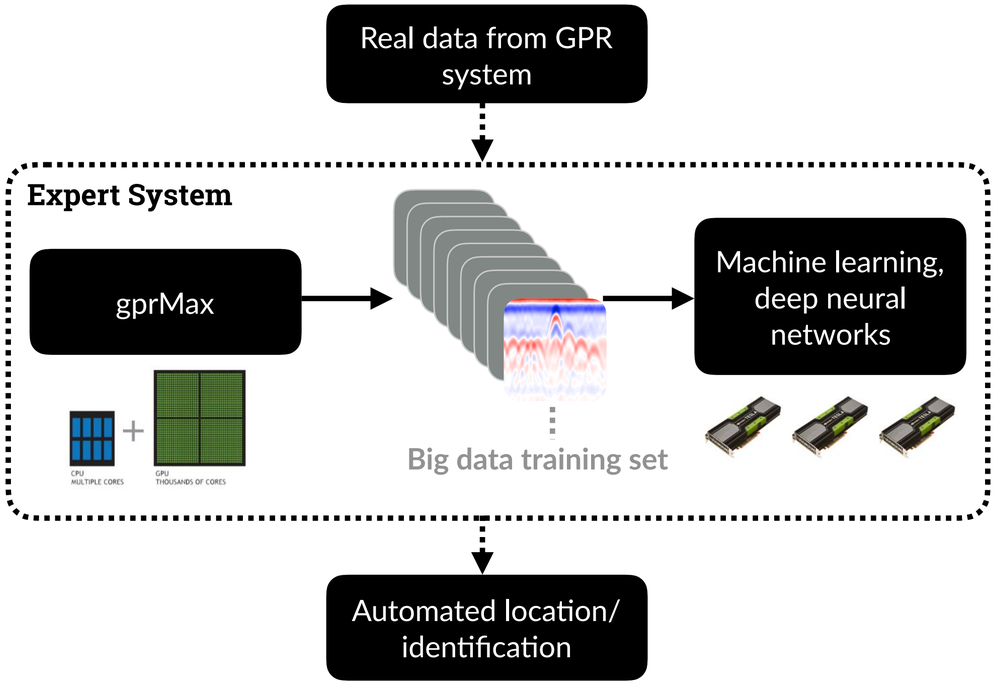
What is gprMax?

gprMax is open source software that simulates electromagnetic wave propagation. It uses Yee's algorithm to solve Maxwell's equations using a Finite-Difference Time-Domain (FDTD) scheme.

It is the most widely used simulation tool in the **Ground Penetrating Radar** (GPR) community, and has been successfully utilised for a diverse range of applications in industry and academia.



EM wave propagation in a complex heterogeneous environment

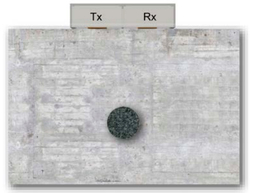


Why is it useful?

Predicting how electromagnetic (EM) waves propagate through naturally occurring or man-made heterogeneous environments is a challenging problem. Many such scenarios exist, in areas of **engineering**, **geophysics**, **archaeology** and **medicine**, that would benefit from improved understanding of this phenomenon.

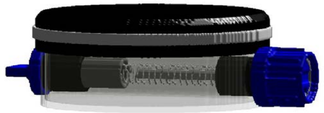
Example GPR-ML scheme

- Synthetic dataset used to effectively train ML-scheme to estimate diameter of rebar and cover depth in in reinforced concrete an accurate and efficient manner

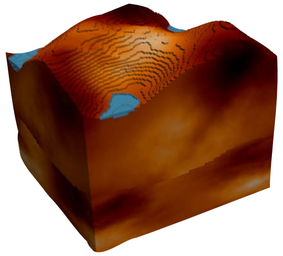


Advanced modelling features

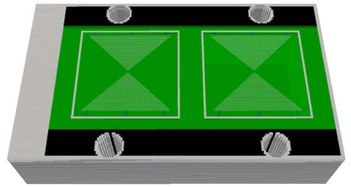
- Realistic soil models
- Fractal-based rough surface simulation
- Builtin modules of complex transducers/antennas & targets
- Anisotropic & dispersive materials
- Sub-gridable meshing



Detailed 3D FDTD mesh of an anti=personnel landmine



Heterogeneous layered soil model with rough surface and water pools



Detailed 3D FDTD mesh of a GPR antenna

Performance

- Parallelised for CPU (OpenMP) and GPU (CUDA)
- **GPU 10-30x faster** than 20 core CPU

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