GPR IMAGING CHALLENGE

THE RATIONALE

As IWAGPR 2017 (http://www.iwagpr2017.org) is being hosted by the University of Edinburgh – the "home" of the GPR simulation software gprMax (http://www.gprmax.com) – we have designed what we believe to be a realistic 3D GPR model which we think offers a challenge for testing GPR processing, imaging, and inversion algorithms.

The idea of using a numerical model to test imaging, inversion, and processing algorithms is not new. It is well established in seismic modelling with, for example, the Marmousi model (http://dx.doi.org/10.1190/1.1437051). However, to our knowledge, no such detailed and realistic 3D model exists for GPR. The use of a realistic model for testing GPR algorithms can offer several advantages:

- algorithms can be tested in a much more robust manner than when using simplistic and clinical models that do not effectively represent the real complex environments and targets that are encountered with GPR;
- there is accurate knowledge of the composition of the targets, their precise location, and the exact makeup of the hosting media. Such detailed knowledge is not possible with experimental or field testing.

Before the planned publication of the detailed construction and composition of this model (to be used as needed by the GPR research community) we would like to offer the modelled data as an imaging and interpretation challenge to GPR researchers that would like to attempt to process them and report their findings during IWAGPR 2017.

THE CHALLENGE

The model is a three-dimensional, near-surface example of a fictional but realistic landmine detection environment. There are several targets in the surveyed area that need to be:

a) detected
b) precisely located
c) identified

The processes employed to achieve the above objectives and to provide a detailed GPR interpretation, are entirely up to the GPR researcher or research group taking part in the challenge. For example, an inversion process may be attempted, or some simple processing accompanied by expert interpretation. Additionally, the number of A-scans or B-scans used to image and interpret the data is also completely up to the researchers taking part.

Full details of the modelled data are provided in the following section of this document, and correspond to the information that would have been available if a real survey had been undertaken instead. The data is available in HDF5 format, which is the standard output from gprMax. Python tools that are part of the gprMax package can be used to load and plot the data. We have also included a script to allow the data to be easily imported into MATLAB if desired.

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MODEL DETAILS

Figure 1 shows the full extent of the model domain within which the data was acquired on a grid comprising of two B-scan sets (in the x and y directions) which are mutually perpendicular. For both the x and y directions the first B-scan began at (0.150m, 0.150m) from the origin. The length of each B-scan is 0.9 m and is made up from 91 A-scans with an inline (i.e. trace) spacing of 0.01m. Table 1 gives a the complete set of parameters for the model.

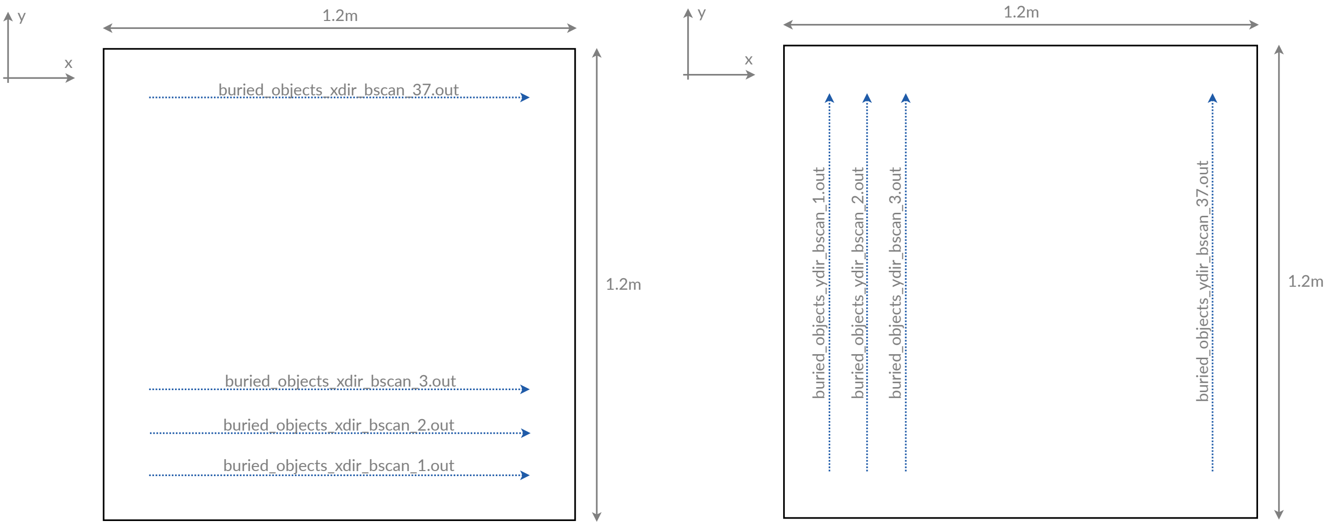

Figure 1 – Layout of data acquisition in x and y direction (drawing not to scale)

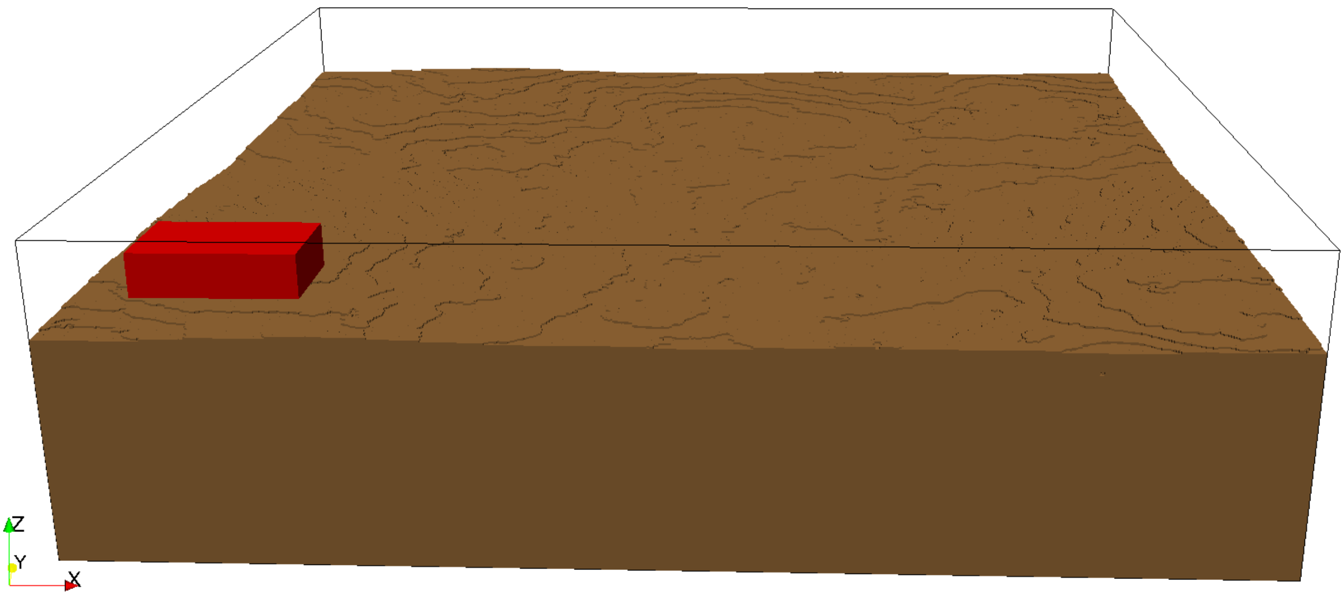

Figure 2 – Visualisation illustrating surface roughness (soil heterogeneities not shown)

Table 1 – Model parameters

Model domain dimensions (x, y, z)	1.2 x 1.2 x 0.328 m
Spatial resolution (x, y, z)	0.002 x 0.002 x 0.002 m
Temporal resolution	3.852 ps
Time window	8 ns
A-scan (trace) sampling interval	0.010 m
A-scans per B-scan	91
B-scan spacing	0.025 m
Number B-scans x-direction	37
Number B-scans y-direction	37
Surface undulation (about mean surface height)	+/- 0.010 m

A model of an antenna like a GSSI 1.5GHz antenna (http://dx.doi.org/10.1190/1.3548506) was used in the simulation. This antenna has a centre frequency of 1.5GHz. The location of the antenna is specified by its geometrical centre in the x and y directions, and by the bottom of its plastic skid in the z direction. For the B-scans where the antenna is moving in the x-direction, the output from the antenna is the y component of the electric field (Ey). For B-scans in the y-direction the output from the antenna is the Ex component. Either component can be easily converted to a voltage by multiplying by the spatial resolution of the model.

The surface of model (z-direction) has a roughness profile (generated using fractals) which undulates +/- 10 mm about the mean height of the surface, as shown in Figure 2. The antenna followed a horizontal path at a height of 10 mm above the mean surface height when acquiring the data. This means that the antenna did not follow the profile of the surface.

Ultimately we will publish, along side this data set, a full description of the composition of the model. We believe this will be a useful asset to the GPR community.

We hope that the model is challenging enough, and we look forward to people submitting their interpretations. We hope some of these results can be presented at IWAGPR 2017. As with all challenges there will be a prize for the best answer judged by a panel of GPR experts.

Good luck!

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