



3d Real-time Ground Penetrating Radar for Anti-Tank mines and IED detection

3D-RADAR
...the ground is no limit!

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Locate Mines, IEDs in Real-time with State of the Art 3d-Radar GPR



Automated real-time detection, notification and marking of objects

- ◆ Detect both plastic and metal objects
- ◆ An antenna array that covers the entire width of a range of vehicles
- ◆ See objects at varying depths
- ◆ Easy to use detection software
- ◆ Independent, well tested and documented results
- ◆ Already deployed in many civil and military applications

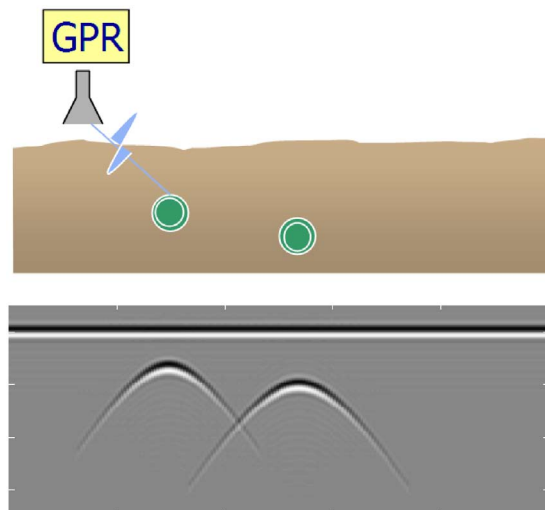
3d-Radar's Ground Penetrating Radar

By exploiting an innovative step-frequency approach for collecting radar signals and combining this with a unique multichannel antenna array, 3d-Radar provides Ground Penetrating Radar (GPR) solutions that have been deployed to forward areas.

GPR Background

GPR is a technique for subsurface mapping based on emission of radio waves. A radar system has a transmitter that emits electromagnetic waves that are reflected by the target and detected by a receiver. When transmitting into the ground, the signal will be reflected whenever the signal velocity changes, thus changes in soil type and buried objects will result in reflection of the radar signal. The motion of the radar will result in a target return looking like hyperbolas (due to the change in distance between radar and target)

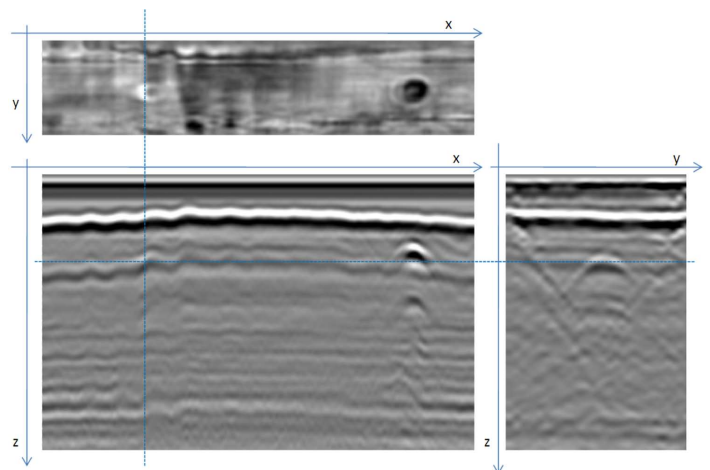
Figure 1: Typical target reflection pattern. The hyperbola shape results from change in radar range.



3d GPR for Mine and IED Detection

In good soil conditions, GPR has successfully been used to locate metal mines, low-metal mines and even non-metallic mines and IEDs. In order to provide a good detection capability, a 3-dimensional mapping of the area is important. By having multiple parallel antennas mounted in an array and scanning a 2-dimensional surface at once, optimum probability of detection is attained. Figure 2 shows resulting imagery with a small plastic IED and a metal anti-tank mine. Due to the 3d mapping, both targets are readily detectable.

Figure 2: A plastic target is masked by ground bounce (reflection between antenna and surface) in along track vertical slice (bottom left). The same target is clearly visible in the cross-track vertical (right) and the horizontal slice (top).



Features and Benefits

- ♦ Real-time analysis and target identification
 - Ideal for Route Clearance
- ♦ Different widths of arrays can be mounted on a variety of vehicles
 - For robotics, manned missions
- ♦ Target detection algorithms can be modified
 - Adaptable to a changing environment
- ♦ Complete De-mining system
 - Suitable to humanitarian de-mining efforts

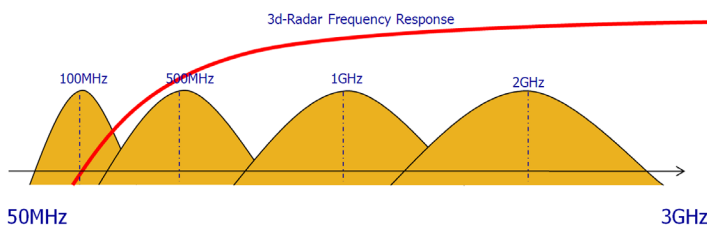
3d-Radar's GPR Solutions

3d-Radar is able to capture this data by employing two innovative approaches. First, a data collection technique called Step Frequency is employed, exploited by a data collection system referred to as a GeoScope™ which is coupled to a unique multi-channel antenna array.

Step Frequency

Step Frequency is an approach where a frequency range is stepped through in incremental frequency steps, usually from low to high, to provide a comprehensive survey of the subsurface. Achieving similar results with more traditional impulse based GPRs, would instead require multiple antennas operating at separate frequencies.

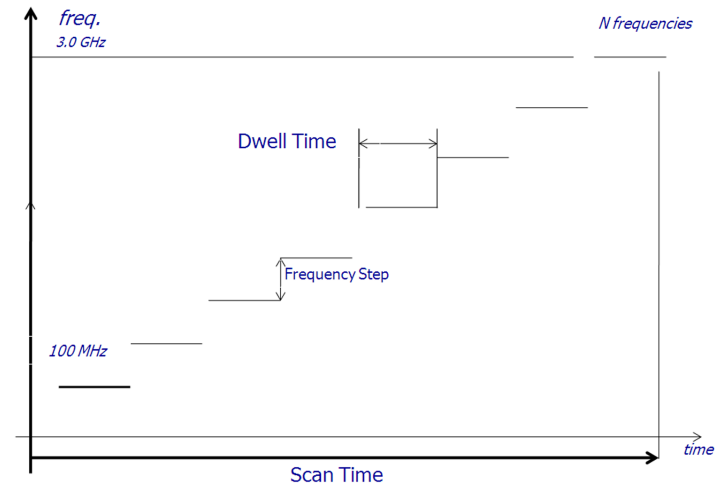
Figure 3: 3d-Radar frequency range coverage when compared with impulse radar systems, which require multiple antennas to capture the same data.



Step Frequency Advantages:

- ♦ 100% efficient integration time.
- ♦ Fully programmable frequency source signature with full spectrum control.
- ♦ The frequency range can be programmed and optimized to each measurement problem. There is no need to waste energy at high frequencies if the soil attenuation is high and medium to low resolution is sufficient for the job.
- ♦ The Step Frequency signal is a low peak-power signal with low probability of interference with other radio systems and jammers. The 3d-Radar Step Frequency system only transmits a burst of energy only when performing a scan.

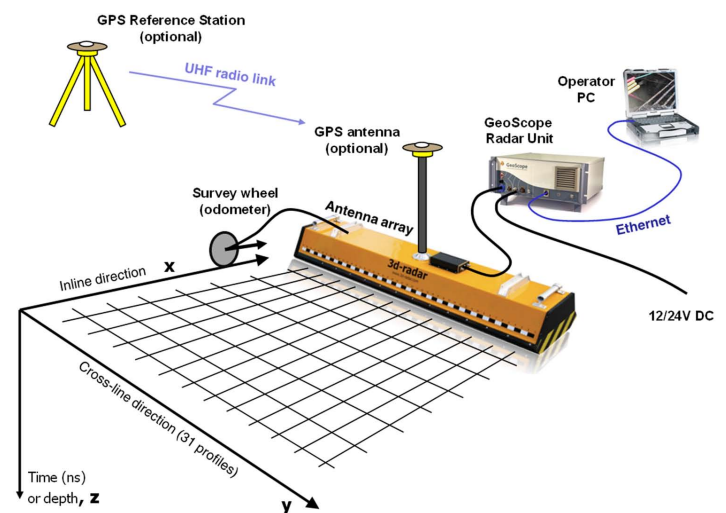
Figure 4: Graphical interpretation of Step Frequency Principles.



GeoScope and Multi-Channel Antenna

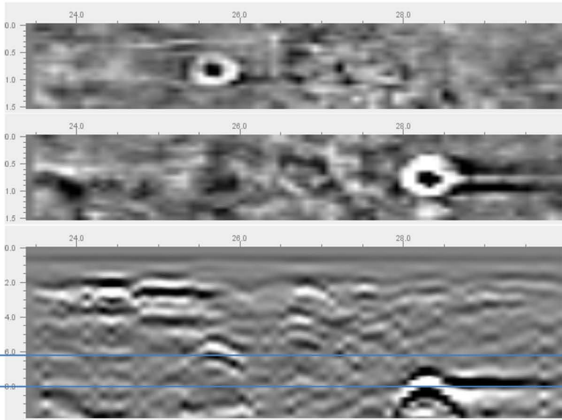
The Step Frequency radar is implemented inside the GeoScope-GS3F GPR, the data collection system and is coupled to the antenna. The GPR operates with an electronically scanned multi-channel antenna array containing up to 31 antennas. The antennas are scanned sequentially by the radar unit producing as much as 31 parallel survey lines in one swath. The unique antenna system consists of air-coupled bow-tie monopole pairs arranged in a quasi-monostatic antenna configuration with practically zero-offset distance. The air-coupled antenna array can be operated at elevations up to 50cm off the ground allowing high-speed surveys.

Figure 5: A typical system showing: DMI, optional GPS wheel, Antenna, GeoScope and Operator PC.



Additional Examples of Collected Data

Figure 6: Plastic and Metal anti-tank mines. The bottom image shows the along track vertical view. The two top images are horizontal views at two different depths. The left-most target is a plastic AT-mine buried at approximately 30cm, while the right-most is a metal mine at approximately 70cm.



Vehicle mounting imposes little problem and interference from the vehicle is negligible. The radar may easily be mounted on a variety of different vehicles.

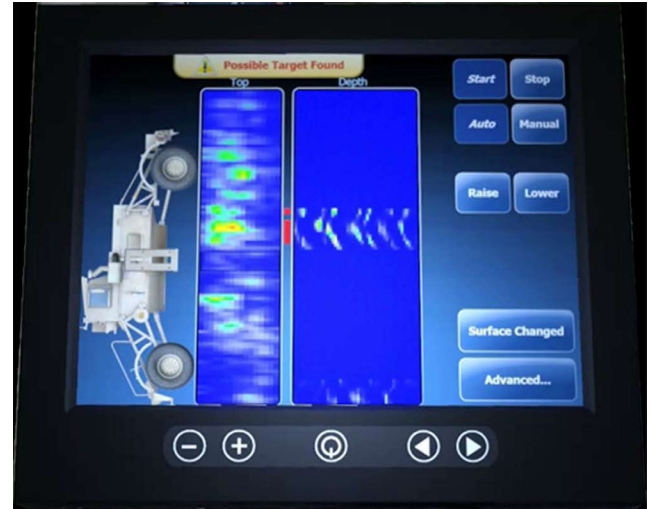
Figure 7: 3d-Radar GPR mounted on a Husky mine clearance vehicle.



Real-time Analysis of Captured Data

Post processing and analysis of the subsurface after collecting data simply is not an option in route clearance missions. To be truly effective in both clearing routes and optimum safety, the ability to display the processed data during data collection is a must-have. 3d-Radar system have this ability and when coupled with software from Exponent, Inc., a close technology partner. This software can automatically trigger visual and audible alarms when a detected object is suspected to be unexploded ordnance.

Figure 8: GUI display created by Exponent Inc. which displays potential threats to the vehicle operator in real-time.



Civil Applications

3d-Radar GPR systems are used worldwide in other capacities. These include:

- ◆ Bridge deck inspection
- ◆ Road surveying and delimitation identification
- ◆ Railway ballast inspection
- ◆ Utility mapping
- ◆ Archeology

All of these application areas benefit from the high-resolution imagery generated, wide survey swath widths and the speeds that data can be collected using 3d-Radar solutions.

Figure 9: 3d-Radar GPR being used in road/bridge survey applications.



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