Adaptive Statistically Based Algorithms for Ground Penetrating Radar Imaging Under Varied Environmental Conditions

The generated GPR images should help identify landmines and improvised explosive devices (IED's)

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Field
Electrical and Computer Engineering

Technology
RADAR image reconstruction algorithms

Key Features
- Clutter resistant
- Provides accurate reflection information on targets of interest
- Statistically based algorithms that can be implemented in near real-time

Stage of Development
Established proof of concept through successful studies using simulated data and real data with known targets that was provided by ARL

Status
Seeking development & licensing partner.

Patent Status pending

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Technology
Howard University (HU) has developed statistically based algorithms for accurately reconstructing ground penetrating radar (GPR) images that can be implemented in near real time. Note, the pixel value of a GPR image is an estimate of the reflection coefficient for the corresponding volume in a scene-of-interest (SOI).The image reconstructing algorithms are based on the maximum-a-posteriori (MAP) method, which is an estimation method that provides a means for incorporating prior information through a judicious choice of the prior probability density function for the unknown reflection coefficients. In applications such as landmine and IED detection, the prior information is that a typical SOI contains few scatterers which means that a large percentage of the unknown reflection coefficients are zero or near zero. By incorporating the known "sparcity" of the reflection coefficients, improved GPR images can be reconstructed by the developed MAP algorithms. Specifically the reconstructed GPR images identify the targets-of-interest, while concurrently reducing ever present clutter and noise.

Benefits of the Technology
The researchers expect real-time or near real-time imaging using the MAP algorithms. An advantage of the proposed algorithms over those based on the popular L1-regularized least-squares method is that they are either parameter free or there is a straightforward and computationally efficient way to determine the parameter for the prior distribution. The researchers have actual computational results using high performance computing architectures that strongly suggest that near real-time imaging is possible now with the MAP algorithms and real-time imaging is expected in the near future. In principle, the MAP algorithms can provide high performance GPR imaging under varied environmental conditions because they are "hands free" algorithms in the sense that they are either parameter free or generate all needed parameters from the data and initial image.

Potential Application for Technologies
These inventions propose a novel way to produce better GPR images and may avoid some of the limitations associated with current techniques used for detecting improvised explosive devices (IED) prior to disarming them. Device detection for devices such as land mines could also benefit from these inventions.

Stage of development
The algorithms related to the inventions have been successfully tested using both simulated and real data provided by the Army Research Laboratory. The results indicate that the algorithms provide significantly enhanced noise suppression when compared to the delay-and-sum algorithm, which is a popular method for reconstruction GPR images. Although the inventions are still in the concept stage, it is important to point out that the MAP algorithms were successfully applied to real data obtained from the ARL SIRE Radar System. More specifically, the data was collected from a test bed with known targets under realistic terrain conditions. The researchers have started to work on extending the algorithms to airborne radar systems.

Opportunity
Howard University is looking for a commercial partner to further develop this technology.