Buried Victim Search & Rescue

Operator deploying GPR at a damaged building site to locate people who may be buried alive!

GPR signals penetrate soils, snow and construction materials to varying depths.

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Disaster Strikes
GPR detects buried human victims

Overview
When disaster strikes and people are buried alive, search and rescue teams need to be readily deployed with simple-to-use search techniques. Teams commonly employ audible detection of victims' cries for help, trained sniffer dogs and even cell phones.

More recently, remote sensing technologies are starting to emerge. This case study examines the use of customized GPR technology to locate buried victims in an experimental facility.

Problem
Search and rescue at a disaster site requires quick location and recovery of buried victims. Site conditions are usually chaotic and access to support is limited. Seeing into the material overlying victims is challenging.

Common burial materials are collapsed building debris, mudflows and avalanche snow. Each environment presents unique challenges with all being opaque to human vision.

While using advanced technology can help, caution must be exercised since failure to detect a response can result in victims not being found. On the other hand, false alarms result in a waste of valuable resources and false hopes.

Testing and validation are critical factors in adoption of any technology. This helps users understand pitfalls and encourages adoption of best-practice procedures.

GPR Contribution to Solution
GPR signals penetrate soils, snow and construction materials to varying depths. For many years, GPR has held potential as a search technique. The barrier to GPR use is the highly cluttered heterogeneous nature of the burial material. GPR sees changes in material properties and being able to see a human victim as distinct from changes in the debris seemed impossible.

A unique attribute of living victims is that they may move - albeit only slightly. Movement can be detected by establishing a GPR at a fixed location and monitoring changes in the GPR record with time. Enhanced signal analysis can further selectively sense periodic motion such as a victim breathing and heart beat which are better indicators of "life".

The Rescue Radar GPR system employs this type of subsurface moving-target detection. Extracting weak motion signals in a hectic and complex environment is challenging, leading to concerns about reliability of detection and the frequency of false positive indications.

The Ontario Provincial Police in Canada have a controlled test site for training and evaluating sniffer dogs. This site has become an idea location for evaluating GPR buried victim location.

Concrete and masonry building debris has been piled up over a network of tunnels to allow "test victims" to crawl into the debris pile. Testing through different thicknesses of material and differing scales of motion define the limits and pitfall of the use of GPR in this way. On-site experiences are helping define best practices for search and rescue teams.

Several tests were carried out at locations with varying

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At the Ontario Provincial Police test facility Rescue Radar interrogates the subsurface for movement while an operator monitors the progress from a remote computer. Status indicators (a yellow square or triangle) exhibit any observed movement. A human life indicator (a pulsing red circle superimposed on the range) is displayed if breathing patterns are detected.

depths of cover (ranging from 1m to 3m) and debris type. A primary goal was to determine detection range for basic motion and more critical breathing indication.

Deployment consisted of placing the sensor on the debris pile where a response is to be obtained. The operator stands at a distance greater than the expected victim burial depth. A wireless link from the operator control unit to the sensor allows the operator to monitor detection progress.

A major source of false alarms are moving objects in the vicinity of the sensor. The heterogeneous nature of the debris causes signals to bounce in all directions and anything that moves will be detected, whether buried or on the surface.

Rescue Radar allows the detection sensitivity and the monitoring period to be adjusted. Further, the monitoring sequences can be repeated several times. Observations at test sites showed:

- increasing sensitivity improves the probability of detection while increasing the likelihood of a false alarm
- increasing the monitoring period improves detection and reduces the potential of a false alarm
- more time is spent clambering over the debris pile to place the sensor than is used to make the measurements
- repeating the measurement several times at the same location improves detection and greatly reduces the false positives
- all emergency sites have radio and cell phone communications which can interfere with the GPR so having an integrated background noise monitor is a critical practice
- use of a wireless link to a remote operator greatly reduces the likelihood of the operator movement creating a false alarm.
- measurements over a regular grid pattern enhance detection probability
- not placing the GPR on obvious metal objects is an important best-practice.

Results & Benefits

This case study explores practicality and reliability of GPR for buried victim location. Some key observations are

- Rescue Radar detected a moving person through 2-3m of rubble present at this site.
- Operators were readily able to use the system with virtually no training.
- Moving rubble and moving structures on surface close to the sensor can lead to false alarms
- Local cell phones and radio communications create background radio noise and reduce system sensitivity.
- Target recognition occurred in less than 1 minute.
- Rescue Radar's repetitive cycle assessments, adjustable sensitivity, and noise monitor increase operator confidence and reduce false alarms

GPR responses vary greatly depending on the target being sought and the host material. GPR response variability can be challenging to new GPR users. When learning about GPR, the best practice is to review several similar case studies to develop an understanding of variability. Check for other insightful information on the resources tab to learn more about GPR. Use Contact Us or Ask-the-Expert to reach our Application Specialists who can help you tap into Sensors & Software's vast array of technical information.

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