Subsurface Imaging Using Ground Penetrating Radar Measurements

ICACECS 2020
Inverse Scattering and Data Processing
Ground-penetrating Imaging Radar Development for Bridge Deck and Road Bed Inspection
12th EAI International Conference on Mobile Multimedia Communications, Mobimedia 2019, 29th - 30th June 2019, Weihai, China
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Phase 1 Report on Sensor Technology, Data Fusion and Data Interpretation for Site Characterization
Proceedings of the International Symposium on Engineering under Uncertainty: Safety Assessment and Management (ISEUSAM - 2012)
Recent Advances in GPR Imaging
Technologies and Applications : Proceedings of the Second Government Workshop on GPR : October 26-28, 1993, Fawcett Center, The Ohio State University, Columbus, Ohio
Advanced Ground-penetrating Radar System and Signal Analysis for High-performance Tomographic Subsurface Imaging and Identification
Radar Technology
Seismic Diffraction
Final Report
Tomographic Site Characterization Using CPT, ERT, and GPR. Innovative Technology Summary Report
Seeing the Unseen. Geophysics and Landscape Archaeology
Compressive Sensing for Urban Radar
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Radar Technology
Advanced Techniques for Ground Penetrating Radar Imaging
Ground Penetrating Radar Theory and Applications
Near-surface Geophysics

CALLAHAN DUNCAN

ICACECS 2020 Springer Science & Business Media
International Symposium on Engineering under Uncertainty: Safety Assessment and Management (ISEUSAM - 2012) is organized by Bengal Engineering and Science University, India during the first week of January 2012 at Kolkata. The

primary aim of ISEUSAM 2012 is to provide a platform to facilitate the discussion for a better understanding and management of uncertainty and risk, encompassing various aspects of safety and reliability of engineering systems. The conference received an overwhelming response from national as well as international scholars, experts and delegates from different parts of the world. Papers received from authors of several countries including Australia, Canada, China, Germany, Italy, UAE, UK and USA, besides India. More than two hundred authors have shown their interest in the symposium. The Proceedings presents ninety two high quality papers which address issues of uncertainty encompassing various fields of engineering, i.e. uncertainty analysis and modelling, structural reliability, geotechnical engineering, vibration control, earthquake engineering, environmental engineering, stochastic dynamics, transportation system, system identification and damage assessment, and infrastructure engineering.

Inverse Scattering and Data Processing Academic Press

Ground penetrating radar (GPR) has become one of the key technologies in subsurface sensing and, in general, in non-destructive testing (NDT), since it is able to detect both metallic and nonmetallic targets. GPR for NDT has been successfully introduced in a wide range of sectors, such as mining and geology, glaciology, civil engineering and civil works, archaeology, and security and defense. In recent decades, improvements in georeferencing and positioning systems have enabled the introduction of synthetic aperture radar (SAR) techniques in GPR systems, yielding GPR-SAR systems capable of providing high-resolution microwave images. In parallel, the radiofrequency front-end of GPR systems has been optimized in terms of compactness (e.g., smaller Tx/Rx antennas) and cost. These advances, combined with improvements in autonomous platforms, such as unmanned terrestrial and aerial vehicles, have fostered new fields of application for GPR, where fast and reliable detection capabilities are demanded. In addition, processing techniques have been improved, taking advantage of the research conducted in related fields like inverse scattering and imaging. As a result, novel and robust algorithms have been developed for clutter reduction, automatic target recognition, and efficient processing of large sets of measurements to enable real-time imaging, among others. This Special Issue provides an overview of the state of the art in GPR imaging, focusing on the latest advances from both hardware and software perspectives.

Ground-penetrating Imaging Radar Development for Bridge Deck and Road Bed Inspection CRC Press

The Department of Energy has identified the location and characterization of subsurface contaminants and the characterization of the subsurface as a priority need. Many DOE facilities are in need of subsurface imaging in the vadose and saturated zones. This includes (1) the detection and characterization of metal and concrete structures, (2) the characterization of waste pits (for both contents and integrity) and (3) mapping the complex geological/hydrological framework of the vadose and saturated zones. The DOE has identified ground penetrating radar (GPR) as a method that

can non-invasively map transportation pathways and vadose zone heterogeneity. An advanced GPR system and advanced subsurface modeling, processing, imaging, and inversion techniques can be directly applied to several DOE science needs in more than one focus area and at many sites. Needs for enhanced subsurface imaging have been identified at Hanford, INEEL, SRS, ORNL, LLNL, SNL, LANL, and many other sites. In fact, needs for better subsurface imaging probably exist at all DOE sites. However, GPR performance is often inadequate due to increased attenuation and dispersion when soil conductivities are high.
12th EAI International Conference on Mobile Multimedia Communications, Mobimedia 2019, 29th - 30th June 2019, Weihai, China Subsurface Imaging with Ground Penetrating Radarשמוש הדרכה לבמלוןImproving Ground Penetrating Radar Imaging in High Loss Environments by Coordinated System Development, Data Processing, Numerical Modeling, and Visualization Methods with Applications to Site CharacterizationThe Department of Energy has identified the location and characterization of subsurface contaminants and the characterization of the subsurface as a priority need. Many DOE facilities are in need of subsurface imaging in the vadose and saturated zones. This includes (1) the detection and characterization of metal and concrete structures, (2) the characterization of waste pits (for both contents and integrity) and (3) mapping the complex geological/hydrological framework of the vadose and saturated zones. The DOE has identified ground penetrating radar (GPR) as a method that can non-invasively map transportation pathways and vadose zone heterogeneity. An advanced GPR system and advanced subsurface modeling, processing, imaging, and inversion techniques can be directly applied to several DOE science needs in more than one focus area and at many sites. Needs for enhanced subsurface imaging have been identified at Hanford, INEEL, SRS, ORNL, LLNL, SNL, LANL, and many other sites. In fact, needs for better subsurface imaging probably exist at all DOE sites. However, GPR performance is often inadequate due to increased attenuation and dispersion when soil conductivities are high.Advanced Ground-penetrating Radar System and Signal Analysis for High-performance Tomographic Subsurface Imaging and IdentificationImproving Ground Penetrating Radar Imaging in High Loss Environments by Coordinated System Development, Data Processing, Numerical Modeling, & Visualization ...The Department of Energy has identified the location and characterization of subsurface contaminants and the characterization of the subsurface as a priority need. Many DOE facilities are in need of subsurface imaging in the vadose and saturated zones. This includes (1) the detection and characterization of metal and concrete structures, (2) the characterization of waste pits (for both contents and integrity) and (3) mapping the complex geological/hydrological framework of the vadose and saturated zones. The DOE has identified ground penetrating radar (GPR) as a method that can non-invasively map transportation pathways and vadose zone heterogeneity. An advanced GPR system and advanced subsurface modeling, processing, imaging, and inversion techniques can be directly applied to several DOE science needs in more than one focus area and at many

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TOMOGRAPHIC SITE CHARACTERIZATION USING CPT, ERT, AND GPR. MDPI

The Special Issue (SI) “Recent Advances in GPR Imaging” offers an up-to-date overview of state-of-the-art research activities dealing with the development of Ground Penetrating Radar (GPR) technology and its recent advances in imaging in the different fields of application. In fact, the advances experimented with over the last few decades with regard to the appearance of new GPR systems and the need to manage large amounts of data suggest an increasing interest in the development of new signal processing algorithms and modeling, as well as in the use of three-dimensional (3D) imaging techniques.

Enhancements to and Characterization of the Very Early Time Electromagnetic (VETEM) Prototype Instrument and Applications to Shallow Subsurface Imaging at Sites in the DOE Complex. 1998 Annual Progress Report National Academies Press

The US Department of Energy (DOE) is responsible for the cleanup of inactive DOE sites and for bringing DOE sites and facilities into compliance with federal, state, and local laws and regulations. The DOE's Office of Environmental Management (EM) needs advanced technologies that can make environmental restoration and waste management operations more efficient and less costly. These techniques are required to better characterize the physical, hydrogeological, and chemical properties of the subsurface while minimizing and optimizing the use of boreholes and monitoring wells. Today the cone penetrometer technique (CPT) is

demonstrating the value of a minimally invasive deployment system for site characterization. Applied Research Associates, Inc. is developing two new sensor packages for site characterization and monitoring. The two new methods are: (1) Electrical Resistivity Tomography (ERT); and (2) Ground Penetrating Radar (GPR) Tomography. These sensor systems are now integrated with the CPT. The results of this program now make it possible to install ERT and GPR units by CPT methods and thereby reduce installation costs and total costs for ERT and GPR surveys. These two techniques can complement each other in regions of low resistivity where ERT is more effective and regions of high resistivity where GPR is more effective. The results show that CPT-installed GeoWells can be used for both ERT and GPR borehole tomographic subsurface imaging. These two imaging techniques can be used for environmental site characterization and monitoring have numerous and diverse applications within site cleanup and waste management operations.

Delineate Subsurface Structures with Ground Penetrating Radar European Alliance for Innovation

Future Application and Middleware Technology on e-Science presents selected papers from the 2008 Korea e-Science All-Hands-Meeting (AHM 2008). Hosted by the Korea Institute of Science and Technology Information, this meeting was designed to bring together developers and users of e-Science applications and enabling information technologies from international and interdisciplinary research communities. The AHM 2008 conference served as a forum for engineers and scientists to present state-of-the-art research and product/tool developments, and to highlight related activities in all fields of e-Science. The works presented in this edited volume bring together cross-disciplinary information on e-Science in one cohesive source. This book is suitable for the professional audience composed of industry researchers and practitioners of e-Science. This volume should also be suitable for advanced-level students in the field.

Mobimedia 2019 Elsevier

The objective of this project is to enhance the state-of-the-art of electromagnetic imaging of the shallow (0 to 5 m) subsurface in electrically conductive media where ground penetrating radar (GPR) provides insufficient penetration and time domain electromagnetic (TEM) systems provide insufficient resolution. This objective is being pursued by instrumentation enhancements to the existing very early time electromagnetic (VETEM) system coupled with physical and numerical modeling. Success in this endeavor will improve the speed and accuracy of waste pit and trench location and characterization, and could have additional applications to shallow DNAPL and LNAPL spill and cleanup monitoring, clay cap integrity assessment, and landfill stabilization monitoring. This could result in significant savings in time and money during characterization, remediation, and decommissioning of facilities. This report summarizes accomplishments after 8 months of a three-year project. The authors have focused mainly on instrumentation and numerical modeling during this time.

Introduction to Ground Penetrating Radar John Wiley & Sons

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Proceedings of International Conference on Advances in Computer Engineering and Communication Systems IntechOpen

This book comprises the best deliberations with the theme “Smart Innovations in Mezzanine Technologies, Data Analytics, Networks and Communication Systems” in the “International Conference on Advances in Computer Engineering and Communication Systems (ICACECS 2020)”, organized by the Department of Computer Science and Engineering, VNR Vignana Jyothi Institute of Engineering and Technology. The book provides insights on the recent trends and developments in the field of computer science with a special focus on the mezzanine technologies and creates an arena for collaborative innovation. The book focuses on advanced topics in artificial intelligence, machine learning, data mining and big data computing, cloud computing, Internet on things, distributed computing and smart systems.

Signals, Targets, and Applications SEG Books

The objective of this applied research and development project is to develop a system known as '3-D SISAR'. This system consists of a ground penetrating radar with software algorithms designed for the detection, location, and identification of buried objects in the underground hazardous waste environments found at DOE storage sites. Three-dimensional maps of the object locations will be produced which can assist the development of remediation strategies and the characterization of the digface during remediation operations. It is expected that the 3-D SISAR will also prove useful for monitoring hydrocarbon based contaminant migration after remediation. The underground imaging technique being developed under this contract utilizes a spotlight mode Synthetic Aperture Radar (SAR) approach which, due to its inherent stand-off capability, will permit the rapid survey of a site and achieve a high degree of productivity over large areas. When deployed from an airborne platform, the stand-off techniques is also seen as a way to overcome practical survey limitations encountered at vegetated sites.

Techniques for Real World Ground Penetrating Radar Data Analysis SEG Books

We are delighted to introduce the proceedings of the 12th EAI International Conference on on Mobile Multimedia Communications (MobiMedia 2019). This conference has brought researchers, developers and practitioners around the world who are developing multimedia services and applications in mobile environments. Developing and leveraging multimedia services and applications in mobile environment requires adopting an interdisciplinary approach where multimedia, networking and physical layer issues are addressed jointly. Content features analysis and coding, media access control, multimedia flow and error control, cross-layer optimization, Quality of Experience (QoE), media cloud as well as mobility management and security protocols are research challenges that need to be carefully examined when designing new mobile media architectures. We also need to put a great effort in designing applications that take into

account the way the user perceives the overall quality of the provided service. Within this scope, MobiMedia is intended to provide a unique international forum for researchers from industry and academia, working on multimedia coding, mobile communications and networking fields, to study new technologies, applications and standards. Original unpublished contributions are solicited that can improve the knowledge and practice in the integrated design of efficient technologies and the relevant provision of advanced mobile multimedia applications

Improving Ground Penetrating Radar Imaging in High Loss Environments by Coordinated System Development, Data Processing, Numerical Modeling, & Visualization ... BoD – Books on Demand

A real-world guide to practical applications of groundpenetrating radar (GPR) The nondestructive nature of ground penetrating radar makes itan important and popular method of subsurface imaging, but it is ahighly specialized field, requiring a deep understanding of theunderlying science for successful application. Introduction toGround Penetrating Radar: Inverse Scattering and DataProcessing provides experienced professionals with thebackground they need to ensure precise data collection andanalysis. Written to build upon the information presented in more generalintroductory volumes, the book discusses the fundamentalmathematical, physical, and engineering principles upon which GPRis built. Real-world examples and field data provide readers anaccurate view of day-to-day GPR use. Topics include: 2D scattering for dielectric and magnetic targets 3D scattering equations and migration algorithms Host medium characterization and diffraction tomography Time and frequency steps in GPR data sampling The Born approximation and the singular valuedecomposition The six appendices contain the mathematical proofs of allexamples discussed throughout the book. Introduction to GroundPenetrating Radar: Inverse Scattering and Data Processing is acomprehensive resource that will prove invaluable in the field.

Advances in Agronomy CRC Press

The Department of Energy has identified the location and characterization of subsurface contaminants and the characterization of the subsurface as a priority need. Many DOE facilities are in need of subsurface imaging in the vadose and saturated zones. This includes (1) the detection and characterization of metal and concrete structures, (2) the characterization of waste pits (for both contents and integrity) and (3) mapping the complex geological/hydrological framework of the vadose and saturated zones. The DOE has identified ground penetrating radar (GPR) as a method that can non-invasively map transportation pathways and vadose zone heterogeneity. An advanced GPR system and advanced subsurface modeling, processing, imaging, and inversion techniques can be directly applied to several DOE science needs in more than one focus area and at many sites. Needs for enhanced subsurface imaging have been identified at Hanford, INEEL, SRS, ORNL, LLNL, SNL, LANL, and many other sites. In fact, needs for better subsurface imaging probably exist at all DOE sites. However, GPR performance is often inadequate due to increased attenuation and dispersion when soil conductivities are high. Our objective is to

extend the limits of performance of GPR by improvements to both hardware and numerical computation. The key features include (1) greater dynamic range through real time digitizing, receiver gain improvements, and high output pulser, (2) modified, fully characterized antennas with sensors to allow dynamic determination of the changing radiated waveform, (3) modified deconvolution and depth migration algorithms exploiting the new antenna output information, (4) development of automatic full waveform inversion made possible by the known radiated pulse shape.

Subsurface Imaging with Ground Penetrating Radar Springer Science & Business Media

Advances in Agronomy continues to be recognized as a leading reference and a first-rate source for the latest research in agronomy. As always, the subjects covered are varied and exemplary of the myriad of subject matter dealt with by this long-running serial. Maintains the highest impact factor among serial publications in agriculture Presents timely reviews on important agronomy issues Enjoys a long-standing reputation for excellence in the field

Improving Ground Penetrating Radar Imaging in High Loss Environments by Coordinated System Development, Data Processing, Numerical Modeling, and Visualization Methods with Applications to Site Characterization CRC Press

The United States has more than 65 active or potentially active volcanoes, more than those of all other countries except Indonesia and Japan. During the twentieth century, volcanic eruptions in Alaska, California, Hawaii, and Washington devastated thousands of square kilometers of land, caused substantial economic and societal disruption and, in some instances, loss of life. More than 50 U.S. volcanoes have erupted one or more times in the past 200 years. Recently, there have been major advances in our understanding of how volcanoes work. This is partly because of detailed studies of eruptions and partly because of advances in global communications, remote sensing, and interdisciplinary cooperation. The mission of the Volcano Hazards Program (VHP) is to "lessen the harmful impacts of volcanic activity by monitoring active and potentially active volcanoes, assessing their hazards, responding to volcanic crises, and conducting research on how volcanoes work." To provide a fresh perspective and guidance to the VHP about the future of the program, the Geologic and Water Resources Divisions of the United States Geological Survey (USGS) requested that the National Research Council conduct an independent and comprehensive review. Review of the U. S. Geological Survey's Volcano Hazards Program is organized around the three components of hazards mitigation. Chapter 2 deals with research and hazard assessment. Chapter 3 covers monitoring and Chapter 4 discusses crisis response and other forms of outreach conducted by the VHP. Chapter 5 describes various cross-cutting programmatic issues such as staffing levels, data formats, and partnerships. Chapter 6 offers a vision for the future of the Volcano Hazards Program, and Chapter 7 summarizes the conclusions and recommendations of the preceding chapters. Throughout the report, major conclusions are printed in italics and recommendations in bold type. The committee has written this report for

several different audiences. The main audience is upper management within the USGS and the VHP. However, the committee believes that scientists within the VHP will also find the report valuable. The report is written in such a manner as to be useful to congressional staff as well.

Physics-based Subsurface Information Extraction by Parametric Inversion Springer Nature

The use of diffraction imaging to complement the seismic reflection method is rapidly gaining momentum in the oil and gas industry. As the industry moves toward exploiting smaller and more complex conventional reservoirs and extensive new unconventional resource plays, the application of the seismic diffraction method to image sub-wavelength features such as small-scale faults, fractures and stratigraphic pinchouts is expected to increase dramatically over the next few years. “Seismic Diffraction” covers seismic diffraction theory, modeling, observation, and imaging. Papers and discussion include an overview of seismic diffractions, including classic papers which introduced the potential of diffraction phenomena in seismic processing; papers on the forward modeling of seismic diffractions, with an emphasis on the theoretical principles; papers which describe techniques for diffraction mathematical modeling as well as laboratory experiments for the physical modeling of diffractions; key papers dealing with the observation of seismic diffractions, in near-surface-, reservoir-, as well as crustal studies; and key papers on diffraction imaging.

Use of Surface and Borehole Ground Penetrating Radar in Geologic and Engineering Investigations of Transportation Projects Mdpi AG

This project investigates the use of ground penetrating radar (GPR) subsurface imaging in transportation projects. Knowledge of shallow subsurface geologic conditions is critical to planning, constructing and maintaining transportation infrastructure, such as roads, bridges, tunnels and railroads. Transportation projects rely heavily on drilled boreholes for characterization of subsurface geology. A borehole provides accurate information at a single location (one-dimensional) and several test borings are commonly required in order to determine the lateral extent of features of interest. Near-surface geophysical methods offer the capability to complement test borings by providing two- and three-dimensional images of the subsurface, away and between boreholes. Such capability can be valuable in mapping features of limited lateral extent, such as discontinuous strata, faults and fracture zones, boulder fields and voids. Ground-penetrating radar (GPR) is a non-invasive, non-destructive, high-frequency electromagnetic method that provides high resolution imaging of electrically resistive environments. GPR can be deployed on the surface and in boreholes, and it can provide observations in two-dimensions (cross-sections) and three-dimensions (volumes). GPR data used in conjunction with corehole data offer the capability to accurately map subsurface features of interest. GPR imaging of the subsurface can complement and enhance the subsurface information provided by test borings. Furthermore, GPR can potentially reduce the number of borings required in a transportation project. The objective of the project was to evaluate the utility of GPR technology in addressing

Kansas transportation geologic and engineering questions. Three GPR studies completed during the course of this project were: GPR Imaging of Bedrock along the Kansas River at Highway K-18 near Manhattan, Kansas. GPR Imaging of the Ogallala Formation at Highway US-50, Near Cimarron, Kansas. Borehole GPR Detection of Subsurface Voids at Kansas Highway 69 Pittsburg Bypass.

Review of the U.S. Geological Survey's Volcano Hazards Program Springer

Rock glaciers are dynamic landforms and, as such, exhibit interesting and welldeveloped structural features, which translate to surface morphology in the form of ridges and furrows. These distinguishing features have led researchers to study the physics behind the movement and internal deformation of rock glaciers. For years researchers had no access to the internal makeup of rock glaciers. Thus, proposed models and discussion have been based on theoretical concepts of electromagnetic (EM) wave propogation. With the application of ground penetrating radar (GPR) to provide a view of the interior structure of a rock glacier, researchers had "real" data to verify their models. However, no comparison has been made between a GPR profile and an actual cross-section of a rock glacier. The purpose of this thesis is to validate the fidelity of GPR in showing the actual structure of a rock glacier. A trench that was excavated through the toe of a rock glacier on Mount Mestas in south central Colorado provided a view of the actual structure of the landform. The structure in the trench was compared with GPR and EM data. The GPR study was conducted using a PulsEKKOTM 100A subsurface imaging radar with 25, 50, and 100 MHz antennas, to detect dielectric contrasts within the rock glacier. A frequency domain EM34 by Geonics LtdTM was also used to supplement the GPR data by measuring the rock glacier's conductivity at various depths. This thesis proved, by utilizing statistics, that GPR is a useful tool in visualizing the interior structure of rock glaciers. The 100 MHz antennas clearly show small scale reflection horizons caused by changes in clast orientation and subsurface material composition. These events coincide with structures seen in the trench. Individual clasts greater than 0.375 m were also recognized as point sources in the GPR profiles. Large continuous bedding layers were observed with the 25 and 50 MHz antennas, which reflect the structure seen in the trench. A large scale thrust fault was also located with the GPR. However, this was not visible in the panoramic photograph because the fault occurs below the base of the trench.

Mount Mestas, Colorado, USA

This thesis reports on sparsity-based multipath exploitation methods for through-the-wall radar imaging. Multipath creates ambiguities in the measurements provoking unwanted ghost targets in the image. This book describes sparse reconstruction methods that are not only suppressing the ghost targets, but using multipath to one’s advantage. With adopting the compressive sensing principle, fewer measurements are required for image reconstruction as compared to conventional techniques. The book describes the development of a comprehensive signal model and some associated reconstruction methods that can deal with many relevant scenarios, such as clutter from building structures, secondary reflections from interior walls,

as well as stationary and moving targets, in urban radar imaging. The described methods are evaluated here using simulated as well as measured data from semi-controlled laboratory experiments.