remote sensing

Editorial

Special Issue "Ground Penetrating Radar (GPR) Applications in Civil Infrastructure Systems"

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This Special Issue includes a collection of papers that address the practical applications of GPR to various civil infrastructure systems. The manuscripts involve the performance of GPR in defect detection, novel data processing and interpretation techniques, deterioration and rehabilitation models, and GPR applications in the inspection, corrosion mapping, condition assessment, and asset management of concrete structures. This editorial summarizes the content of this Special Issue.

1. Characteristics of GPR

GPR is a geophysical method, based on the propagation behavior of electro-magnetic (EM) waves. A GPR system for concrete inspection generally consists of a central unit (computer), pulse generator, transmitting and receiving antennae, and video monitor. A GPR system could be equipped with two so-called bi-static antennae, one for transmission and the other for receiving, or it might be equipped with one antenna that both transmits and receives, known as a mono-static antenna. As the GPR is dragged over the structure, the pulses are emitted by the antenna and transmitted through different layers of materials. Accordingly, part of the wave reflects back when it strikes the interface between two layers with different dielectric constants, and the remaining energy is absorbed. The subsurface conditions are evaluated by analyzing the GPR profiles that include the time delays and amplitudes of reflected signals.

2. Merits of GPR

As a result of the numerous characteristics of GPR, this technique is used for the condition assessment of several concrete structures such as highways, bridge decks, parking lots, foundation systems, retaining walls, foundations, and subways. For those structures, it is appropriate to use a highly portable radar system with a ground-coupled, mono-42 static antenna. However, for particular projects, such as road condition evaluation, an air-launched (horn) antenna is usually used.

3. Content of This Special Issue

The 10 published papers in this Special Issue cover different civil infrastructure systems. In the first paper [1], GPR was used in conjunction with geomatics techniques to create an integrated model for archaeological sites. The proposed methodology combined aerial and close-range photogrammetry, geographic information systems (GIS), and GPR technologies to obtain essential geospatial and geophysical data for preserving archaeological sites.

RC bridge elements were investigated in the second paper [2], where a deterioration map was generated through the automated detection of hyperbolas in GPR profiles and classification was carried out based on mathematical modeling.

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A condition assessment for another infrastructure system (rail track) was conducted in the third paper [3] using Gabor-filter-based image segmentation. In this study, quantitative measures were obtained to assist the decision makers in railroad condition assessment.

The fourth paper [4] evaluated the tunnel conditions through the two-dimensional forward modeling (TDFM) simulation of GPR measurements. In this study, the tunnel lining was detected via the Fresnel reflection coefficient in both A-scan and B-scan mode to estimate the thinning lining of the tunnels.

Pavement structures were analyzed in the fifth paper [5] after processing the GPR data using principal-singular-vector utilization for modal analysis (PUMA). A key success factor here is that the simulation iterations showed good results.

In the sixth paper [6], a guidance system was designed to guide the GPR operator along survey paths, which were similar to the flight path of a drone. This study indicated that with the guidance system, the image resolution and generated C-scans had better accuracy.

The merits and drawbacks of GPR subsurface surveys on Korean expressways were investigated in the seventh paper [7]. Two different types of multichannel GPR were employed to study the depth and detection performance of abnormal objects. The remaining three papers [8–10] cover various topics and are classified as technical notes in this Special Issue.

4. Conclusions

GPR as a non-destructive evaluation technique has proven to be the method of choice; therefore, a multitude of applications have been developed, especially in civil infrastructure systems. Numerous researchers have benefited from these applications and continue to do so, more than 100 years from when it was first designed.

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