A geophysical sensor suite for detecting near-surface anomalies in urban environments

Meyer Taffel, UMD, College Park, MD
Heidi Myers, UMD, College Park, MD
Alexandra Pick-Aluas, UMD, College Park, MD
Shelley (Shiyu) Wang, UMD, College Park, MD
Elaine Jaross, UMD, College Park, MD
Vedran Lekic, UMD, College Park, MD
Daniel Lathrop, UMD, College Park, MD

Abstract

Near-surface hazards in the urban environment include subsurface built infrastructure for civil engineering digs and, in war-zones, unexploded ordnance (UXOs) and landmines. Locating these hazards remains challenging due to inaccurate mapping and record-keeping and the expense associated with digging. Geophysical techniques offer an indirect, rapid, and inexpensive means of mapping these near-surface hazards. Our team has been developing de novo sensors for mapping these hazards while minimizing sensitivity to natural and anthropogenic sources of noise that can easily swamp signals from buried objects. Our sensor suite includes a tetrahedral magnetic gradiometer, a novel air-launched ground penetrating radar (GPR) system, and a FDEM/TEM coil-based active electromagnetic system. These utilize Pi controllers as well as novel EM coil and amplifier designs. We have integrated commercial sensors for the magnetic gradiometer but have explored an FPGA-based, software-defined, GPR design that could be flown on an uncrewed aerial vehicle (UAV). The combination of sensors enables the system the ability to gather data into a single multilayer map of near-surface buried objects. The fused data from the ensemble of sensors is ideally suited for leveraging machine learning (ML) techniques to detect and characterize anomalies. We gratefully acknowledge support from NSF IIP2044611 and a UMD Provost Grand Challenge Grant.

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