Counter Underground Facilities
Greg Duckworth

Distribution Statement A: Approved for public release: distribution unlimited
Robust Geophone Coupling
PASEM:
Passive Acoustic, Seismic, and Electromagnetic Monitoring
Exploits the signals emitted by activities within the Underground Facility (UGF)
CUGF Ground Sensor System - Functional Prototype

Prototype Sensor Node

Network of Nodes

6 in

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Coherent Signal Processing

Signal estimate:

\[ \Phi = \text{atan}(P_Q/P_R) \]

\[ P = P_I + P_Q \]

Magnetic reference

FFT line tracker & BP filter design

BP filter

60

BP filter

60 + F_R

Generate 60 Hz In-phase and quadrature components

i & Q

Filter design

Sensor Output

Acoustic

Seismic

EM
Small "N" systems
High performance sensors
Small "N" systems
High performance sensors

Large "N" systems
μ-sensors

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EM noise mitigation approaches

Sensor Choice and Modifications

Passive Vibration Isolation

Active Electronic Noise Cancellation

Platform Choice and Modifications

Noise-reduced B-field output

Noise references

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LAASS EM Inversion Problem

Parametric inversion of EM sources at depth

North

East

Truth: Estimate

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Rural Site

“Urban” Site

Ground Truth Sensors

Collection Platform

Deep Facility

Generators/Ground Truth Sensors

LAASS
Data Collection and Proof-of-Principle Demo

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Interconnect Assessment
Strategic and Tactical Applications

Example Data for Tracer Gas Detection

Scene-Based Gas Estimation

Spectral Radiance Data

Detection of Tracer Gas at Remote Building

Thermal Infrared Composite Scene

Tracer Gas Release Site

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