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Uncertainty-Aware Pipe Location, Orientation, and Radius Estimation Using GPR Data

Uncertainty-aware GPR inversion estimates pipe location/orientation/radius with credible intervals to improve utility-mapping safety.

Researchers at Purdue University have developed an uncertainty-aware method for estimating the location, orientation, and radius of underground pipes using ground-penetrating radar (GPR) data. Accurate underground utility location is critical to preventing costly and hazardous utility strikes, which cause billions of dollars in damages annually in the United States and contribute to delays in project completion. GPR provides a non-destructive technique for detecting and mapping underground pipelines by analyzing electromagnetic wave reflections. However, existing GPR methods often overlook inherent uncertainties and issues related to data quality. The Purdue uncertainty-aware model compensates for this gap by robustly quantifying uncertainty in order to create a buffer zone. With this improvement, construction contractors, utility locating service providers, and excavator manufacturers can better interpret GPR data, supporting safer and more effective underground utility mapping.

Technology Validation:

The uncertainty quantification method was validated using both simulated and field datasets. A forward model was developed for predicting electromagnetic wave travel times from 3D pipe geometries. In addition, researchers created a statistical inference framework for quantifying uncertainties in estimated pipe parameters, including location, horizontal position, orientation (azimuth and inclination), and radius. The framework was shown to output credible intervals and provide measures of estimation reliability. Finally, they developed diagnostic metrics for GPR data quality, including quantitative measures of completeness and consistency.

Advantages:

Technology ID
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Category
Aerospace & Defense/Defense Electronics & Surveillance Technologies

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-Accurately estimates location, orientation, and radius of underground utility pipes

-Quantifies estimate uncertainty, allowing for improved data interpretation

-Reduces the likelihood of hazardous utility strikes

-Supports enhanced jobsite safety

-Increases construction project efficiency

Applications:

-Mapping underground utility pipes for construction and transportation projects.

TRL: 3

Intellectual Property:

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Keywords: Civil Engineering, GPR, Uncertainty Awareness, Underground Pipe Mapping