Impactful Resilient Infrastructure Science and Engineering (IRISE)
-Project Scope of Work-
(FY 2021-22 Annual Work Program)

SUMMARY PAGE

Project Title: Investigating New Underground Utility Location Technologies and Novel Methods to Improve the Safety and Efficiency of Highway Construction

Person Submitting Proposal: Lev Khazanovich

Proposed Funding Period: 09/01/2021 - 09/01/2022

Project Duration: 12 months

Project Cost: $100,000

Project Title: Investigating New Underground Utility Location Technologies and Novel Methods to Improve the Safety and Efficiency of Highway Construction

Problem Statement: Design and construction of highway projects often face the challenge of determining the precise location and types of hazards or conflicts that may exist due to the presence of underground utilities. Currently, locations are identified by requiring known utilities within the highway right of way to be marked in the field (https://www.pa1call.org/). This information is then transferred to the highway construction plans via ground surveys of the markings. The information is derived by the utility companies through passive and active location methods. These methods involve electromagnetic location of the underground pipes and cables. The lateral and depth locations are then depicted on the highway plans. In many instances, the position of the utilities is unknown and not clearly marked in the field. Ground penetrating radars have been used for several decades for locating underground utilities. Although traditional analogous systems are effective and reliable for locating subsurface utilities at shallow depth, they are less reliable for locating deeper utilities, especially if inadequate frequency antennas are used. Recently, new digital and step-frequency antennas and new data interpretation methods have been introduced. These innovations offer an opportunity to improve the accuracy of identifying the type and location of underground utilities. However, there is a lack of guidelines for equipment selection and test protocols that should be used prior to and, potentially, during the excavation. This results in inaccurate or incomplete information on unknown or abandoned utilities. This inaccurate/incomplete information also impacts construction schedules when these unknown locations or types of utilities are encountered.

Project Objectives: Investigate current and emerging technologies that could more accurately determine lateral position and depth of known and unknown utilities to improve safety and optimize schedules for highway construction; develop requirements for the equipment and test protocols for data collection and data analysis.

Project Scope: The project will evaluate and rank the scenarios with underground utilities detections that create challenges for the IRISE consortium members. This will include the types and locations of the utilities, accuracy, complexity, and duration of data analyses of the conventional testing methods, etc. A technology scan of current DOT methods and technologies used across the US as well as new and emerging technologies will be conducted to determine their applicability to highway construction in Pennsylvania. Promising technologies will be identified. The research team will also identify potential test sites with verified location of the underground utilities which detection might be a challenging problem. A field-testing program will be developed to compare the results of these methods to know utilities' locations. Recommendations for the selection of equipment and the test protocols will be developed.

Task Statements:

The objectives of this project will be realized through the completion of the following tasks:

Task A: Identifying IRISE top scenarios for underground utility location

The research team will collect information on the different challenging scenarios that IRISE members encounter regarding the location of underground utilities. Data will be collected from internal IRISE surveys. Members will also be encouraged to suggest scenarios. We will evaluate and rank the scenarios in order to provide priority levels for the tech scan in Task B and for the technology testing in Task C.

Task B: Tech scan for underground utility location

Technologies used for the detection of underground utilities will be identified. The research team will look for both established technologies used by different Departments of Transportation across the country as well as novel and emerging technologies being developed in the US and abroad. The scan will be focused on the scenarios identified in Task A. A literature review will be conducted on the identified technologies describing the technology/device, its advantages and disadvantages, and its applicability to PA needs. Vendors and developers will be contacted for testing and demonstrations.

Task C: Technology controlled field testing

The technologies identified in Task B will be tested based on the scenarios ranked in Task A. Testing sites with verified utility locations will be selected. In addition, if verified field testing sites that represent the scenarios ranked in Task A are unavailable, the research team will design and construct testing structures with embedded faux utilities to test the technologies. Vendors and developers will be invited to test the technologies in this controlled testing setup.

Task D: Recommendations for best technologies

A comparative rank of technologies based on different utility location scenarios will be developed in accordance with results of Task C. Technology will be evaluated based on accuracy, applicability, complexity, and processing time. Testing protocols including data processing and results interpretation for the higher ranked technologies will be prepared.

Task E: Draft Final Report

A draft final report will be prepared to document project activities, findings, and recommendations.

Task F: Final Report

A Final Report taking into consideration comments that were received on the Draft Final Report will be prepared.

Deliverables:

The following deliverables will be provided based on completion of the above tasks:

- *Deliverable #1* – A memo summarizing and ranking the scenarios of underground utility location pointed out by IRISE members.
- *Deliverable #2* – A memo summarizing the identified technologies along with a literature review of the technologies.
- *Deliverable #3* – A memo report with the description and preliminary results of the field program for technology testing
- *Deliverable #4* – A memo report summarizing the complete evaluation and ranking of the tested technologies including recommendations and testing protocol for the higher ranked technologies
- *Deliverable #5* – A draft final report, due 11 months from project initiation.
- *Deliverable #6* – Final report, due 12 months from project initiation.

Key Personnel:

Principal Investigator: Dr. Lev Khazanovich is to provide the technical expertise, project management, and oversight on all project activities.

Other Key Staff:

Postdoctoral Associate: Dr. Lucio Salles de Salles will assist Dr. Khazanovich on all tasks of the project.

Other Personnel:

Two students will contribute to the successful completion of this research effort as described below:
Grad Assistant 1 (TBN)
Undergraduate student (TBN)

Proposed Person-Hours by Task:

Team Member	Task A	Task B	Task C	Task D	Task E	Task F	Total
	Key Project Team Members, Estimated Hours Per Task						
Dr. Lev Khazanovich, PI	6	10	8	20	18	10	72
Dr. Lucio Salles	20	120	100	108	60	40	448
	Other Project Team Members, Estimated Hours Per Task						
TBD, Grad Student	280	400	440	140	120	60	1440
TBD, Hourly Student	10	20	20	0	15	0	65
Total	316	550	568	268	213	110	2025

Schedule:

Months	2021	2022		
	Q4	Q1	Q2	Q3
Task A	X			
Task B	X	X		
Task C		X	X	
Task D			X	X
Task E				X
Task F				X

Budget: The total project cost is $100,030.

Acknowledged By:

Lev Khazanovich
Principal Investigator