Deploying Linear Current Sensing on dynamic platforms for utility mapping in diverse environments

*Caylin A. Hartshorn, Dartmouth College, Hanover, NH, USA*

*Lee J. Perren, U.S. Cold Regions Research Engineering Laboratory, Hanover, NH, USA*

*Benjamin E. Barrowes, U.S. Cold Regions Research Engineering Laboratory, Hanover, NH, USA*

*Fridon Shubitidze, Dartmouth College, Hanover, NH, USA*

Efficient detection and mapping of underground utilities without direct access remains challenging, particularly without reliable ground truth maps. Traditional methods such as ground-penetrating radar (GPR), low-frequency electromagnetic induction (EMI) fields, and invasive excavation each present unique limitations, including restricted detection depth, low resolution, geological noise interference, and high time and cost demands. Recent advances in frequency domain linear current sensing (LCS) offer a promising alternative for locating long metallic subsurface targets. By exciting a linear current, LCS results in less spatial attenuation of the secondary magnetic field compared to the attenuation of the secondary magnetic fields generated by traditional EMI techniques. With suitable excitation, LCS enables detection of long contiguous metallic conductors at large standoff distances of 8 meters or more. This work explores the deployment of LCS technology on dynamic platforms across diverse subsurface environments. UAS-mounted LCS sensors facilitate efficient data collection over challenging terrain, while UUV-mounted LCS sensors could potentially provide an innovative approach to mapping utilities in underwater environments, enabling more accurate detection in regions that were often previously inaccessible using conventional methods.

In this presentation, we assess the quality of the sensor’s data from triaxial receivers at multiple frequencies over linear conductors in soil and fresh water at various depths. We will present data collected by an LCS sensor mounted to a UAS and report on a recent feasibility study that evaluated the potential capability of our surface-deployed LCS sensor to detect submerged utilities up to 13m deep in fresh water. Additionally, we offer insights into potential strategies for optimizing sensor hardware, form factor, and algorithms to enhance detection accuracy and reliability in various operational environments. The findings highlight the potential of LCS-equipped platform capability to enhance subsurface utility mapping, offering a scalable and cost-effective solution for a wide range of applications.