UNMANNED VEHICLE-BASED EMI SENSING FOR UNDERGROUND UTILITIES DETECTION AND MAPPING

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Detecting and mapping underground utilities rapidly and cost-effectively without direct access continues to be a problem within the United States. Unfortunately, reliable ground truth maps are frequently absent or incomplete. Currently, there are many different methods used to locate and map subsurface infrastructures, such as ground penetrating radar (GPR), low-frequency electromagnetic induction (EMI) fields, and invasive excavation. GPR allows for above-ground sensing but has problems related to short detection depth, low resolution, and geological noise. Low-frequency electromagnetic sensors can find metallic infrastructure, however, their detection depth is limited by the sharp decay of the secondary magnetic field. Clamp induction and direct connection low-frequency EMI can increase detection depth but require prior knowledge and access to the utility. Invasive excavation methods are considered extremely accurate, but are by far the least cost-effective technique. Recently, a frequency domain linear current sensing (LCS) technique has been developed and tested for detection and location of long metallic subsurface targets. LCS is a frequency domain EMI technique that can be used to excite a linear current (as opposed to a induction loop current) on long metallic subsurface targets. The secondary magnetic field due to linear currents on long conductors decay significantly slower than the secondary fields from small compact metallic targets associated with traditional EMI techniques. The slower decaying secondary magnetic field allows for a large standoff detection distance of 10 meters or more. Thus, the LCS technique is an ideal candidate for integration onto an unmanned aerial system (UAS) as UAS-mounted sensors often require larger standoff distances from the ground.

In this presentation, we analyze data collected over metallic infrastructure by an LCS gradiometer sensor mounted to a UAS. The challenges and advantages related to using a UAS payload sensor will be explored, including limitations of the detection depth of the system. Our UAS-mounted LCS gradiometer sensor can reduce the time and effort needed to collect data over large areas. Furthermore, operating over challenging geological conditions (e.g. elevation changes, crevasses, or rocky terrain) can be greatly simplified. However, operating the system in an environment not well suited for flying, such as a heavily urbanized or wooded area creates complications. Therefore to mitigate these limitations, in addition to the UAS, in this work we analyze data collected from our sensor mounted on an unmanned ground vehicle (UGV). Namely, we study a UGV-mounted sensor performances under different conditions.