Autonomous Characterization of Chloride and Total Petroleum Hydrocarbons in Contaminated Soils Using Ground-based Robotic Platforms

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Background/Objectives. Investigating the extent of environmental contamination in soils is mainly done through manual sample collection and post-collection analysis in off-site laboratories. This process can be dangerous and time-consuming, especially if the impacted areas are large in extent. Manual sample collection can expose humans to hazardous environments or contamination. Large environments require many samples, often from remote locations, for accurate analyte characterization. This results in a trade-off between accurate characterization of the contaminated area and collection costs and time. These challenges can be addressed, and the investigation process made safer and more accurate by automating the process with soil sampling robotic platforms. Here, we present the results of a multi-year effort to design ground-based vehicles that can autonomously characterize chloride, heavy metals, and TPH in soils using a pXRF sensor or a NIR sensor deployed on wheeled or tracked vehicles.

Approach/Activities. We discuss lessons learned about sample homogenization requirements, about automating sampling and analysis processes, and the impact of these operations on the precision and accuracy of the measurements. In addition, we present algorithms that can be used for adaptive sampling methods to provide a desired characterization objective, namely hotspot identification, contamination extent, or complete coverage, while minimizing travel time and number of samples required to meet data quality objectives.

Results/Lessons Learned. Overall, these investigations provide insights into the different mobility and sensing platforms that can be deployed autonomously, as well as the challenges to achieving full autonomy for contaminated soil characterization.