OPTIMIZING MULTI-SENSOR GEOPHYSICAL OBSERVATIONS ON A UAV FOR UXO DETECTION

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There are 15,000-20,000 injuries and/or deaths that result annually from more than 110 million landmines, unexploded ordnance (UXO), and explosive remnants of war (ERW) buried worldwide. An additional 2.5 million new mines are buried each year, and their removal is dangerous, expensive, and slow. A geophysics-based, cost-efficient, all-terrain, easily deployed, and automatic approach to detection and remediation is needed. Our proposed solution is a multi-sensor package integrated on a quad-copter unmanned aerial vehicle (UAV) that uses machine learning to evaluate terrain and environmental conditions, and chooses which on-board geophysical instrument(s) will yield the most accurate landmine detection results. As we begin building the integrated UAV, we seek to characterize the signal interactions and interferences that may arise between a powered UAV test platform, commercial ground penetrating radar (GPR), and fluxgate magnetometer. The UAV, sourced from our collaborators at Airgility, Inc., is a 1.14m long quadcopter with 66cm propellers and brushless outrunner motors that are driven by electronic speed controllers. To quantify the performance of commercial GPR units when operated above the ground surface, we performed a series of surveys with a GSSI 400MHz GPR at varying heights, scanning across buried inert landmines and known reflectors at typical minefield depths. To quantify magnetometer contamination, we conducted a series of experiments varying fluxgate sensor mounting location on the UAV, and changing driving motor speeds. We discuss multiple field mitigation techniques to identify and reduce the unwanted magnetic field signal from the motors and power wiring, including the development of a magnetic gradiometer. We present the results of these experiments as well as the implications of UAV-associated signal contamination, along with recommendations for suppressing cultural and space weather sources. Finally, we present initial development of a directional, UAV-appropriate GPR unit, leveraging software defined radar. We gratefully acknowledge the support of NSF Grant No. IIP2044611 and DoD NDSEG Fellowship.