UAS Mounted EMI Sensor for UXO Detection and Classification

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Unexploded ordnances (UXO) (i.e., bombs, shells, mortars, land mines, cluster, and other munitions) poses the military and civilian environmental problems worldwide. Such as, due to the ongoing Russia-Ukraine war, it is estimated that about 64 thousand square miles of Ukraine’s territory is littered with UXO, landmines, and improvised explosive devices. The UXO-s are found not only in war and post war zones, but also at active and former military training ranges. Although, in recent years UXO cleanup technologies have been improved significantly by developing and commercializing of advanced electromagnetic induction (EMI) systems for detection, localization, and classification of subsurface UXO, till now the current systems, however, tend to be large and heavy and cannot be readily used in war and/or post-war zones safely, as well as in challenging terrains that do not allow vehicular access. To overcome this limitation, this paper introduces an unmanned aerial system (UAS) mounted EMI sensor for detection and classification camouflage explosive hazards. The system consists of: three 45 cm diameter small and one large transmitter loops; custom design Tx and four vector receivers boards; 11th generation Intel Next Unit Computing with Intel 4-core I7 processor and 4000 Series PicoScope for data acquisition, signals pre-processing, inversion and classification in real time. The three small Tx coils, that produce up to 37 A-m2 moment, are designed to illuminate targets from different sites, and the large Tx coil, with up to 70 A-m2 moment, is used to enhance detection, location, and identification of deep targets. When the excitation pulse is turned off, the Rxs collect target responses at a sample rate of 10MHz. The system weights about 14 pound and is able to collect a static (i.e. hover above a target) and dynamic data sets in form of raw transient decay signals into 30 logarithmically spaced time gates whose center times range from 90 μs to 8.33 ms. The measured data are processed using advanced, physically complete fast forward and inverse EMI models. The data inversion yield target’s location and classification feature parameters in real time. The latter parameters result in a fully classified result. UAS mounted EMI sensor along with the subsurface targets’ detection, and classification performances will be presented and analyzed.