A75 The Use of Near-Infrared Remote Sensing in the Detection of Clandestine Human Remains

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After attending this presentation, attendees will better understand the potential uses of unmanned aerial drones in the detection of clandestine human remains during search missions.

This presentation will impact the forensic science community by introducing a new use for existing drone technology that will allow forensic investigators to quickly, inexpensively, and safely search for clandestine human remains.

Most commonly, searches for clandestine remains have utilized time-consuming methods such as line searches that require the support of many individuals to scour a typically large area. While these methods do yield results, they take time to execute and, in certain places, may actually prove dangerous for the participants.[1] Many additional methods have been tested and utilized in the recovery of human remains, including the use of metal detectors, aerial photography, and ground-penetrating radar, which can be time consuming and expensive.[2] Only in recent years has the use of Near-Infrared (NIR) imagery been experimented with as a means of uncovering clandestine graves and surface remains.[1-3]

As human remains decompose, a large amount of organic matter enters into the surrounding soil, forming a Cadaver Decomposition Island (CDI).[4] Because soils that are organically rich have a different reflectance signature than nearby unaffected soils when viewed with NIR imaging, it is likely that by using NIR photography and drone technology, clandestine remains may be recovered more quickly and more efficiently than has previously been possible.[3] Because NIR photographs can be obtained using small, remotely controlled aircraft or aerial drones, large areas can be surveyed for clandestine remains remotely and rapidly, thereby minimizing the need to involve a substantial group of people in the search. In so doing, potentially dangerous locations can be searched without great risk, disturbances to forensically significant sites will be minimized, and the area that personnel must search will be reduced and more precisely understood.

The present study explores the utility and longevity of NIR cameras mounted to Unmanned Aerial Systems (UAS) in the detection of clandestine human remains. Aerial NIR photographs and soil samples were compiled from 104 identifiable CDIs (i.e., the fertile soil area below and surrounding a decomposing cadaver) at the Forensic Anthropology Research Facility (FARF) at Texas State University in San Marcos, TX. Four surface soil samples were taken from each CDI on the day of the first drone flyover, two from the center, and two from the edge. Half of the soil samples collected from the center of each CDI were sent for analysis of organic materials (specifically organic carbon and nitrogen) at Texas A&M, Department of Soil and Crop Science, while the other half were burned in a muffle furnace at Texas State University to estimate the amount of total carbon within each sample based on the difference between initial soil weight and the ash weight. Each area of FARF that contains or once contained human remains was photographed using a camera with NIR capabilities mounted on UAS. Unused areas of FARF were also examined to determine whether natural disturbances create signatures similar to that of human decomposition.

Results of an unpaired t-test show a significant difference ($p<0.001$) between the NIR spectra signature of true placements (i.e., CDIs) versus that of control sites. Baseline trends indicate that CDIs that are more than approximately two years old cease to be visible in the NIR spectra, while CDIs that are younger than two years, but older than one week, are easily distinguishable from the surrounding soil. While no single chemical factor in the present study has a significant effect on the strength of the NIR signature of a given CDI, a multiple linear regression of organic carbon, total nitrogen, and total carbon presents a strong correlation coefficient ($R=0.670$) between the variate and the strength of the NIR spectra signature. Analysis of Variance (ANOVA) results further indicate that this model does significantly predict the strength of the signature (F (3, 58)=14.647, $p<0.001$).

In conclusion, this study demonstrates the utility and efficiency of unmanned aerial drones mounted with NIR-capable cameras in the remote detection of clandestine human remains. The combination of organic materials such as nitrogen and carbon purged from the body during decomposition creates a unique signature that is visible in the NIR spectrum up to two years after its creation and can be used as a tool on search missions for clandestine human remains.

Reference(s):

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