A74 Remote Sensing of Human Burials

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After attending this presentation, attendees will understand some principles of remote sensing, some characteristics of human burial disturbance that are observable in remotely sensed data, and an example of some analytical approaches to separating disturbance signatures from non-disturbance signatures using an unmarked burial dataset collected at the University of Tennessee Anthropology Research Facility (ARF).

This presentation will impact the forensic science community by providing documented evidence of topographic and spectral signatures for use in narrowing areas-of-interest thought to contain buried human remains, as well as other types of ground disturbances. Further, this research is unique in that it separates signatures of truly clandestine disturbance targets by comparing like-materials (e.g., affected live vegetation to unaffected live vegetation).

In addition to an empty control grave, ten donated human bodies were buried in three differently sized graves at the ARF in February 2013, for a total of four disturbance targets. In 2013 and 2014, multiple terrestrial Light Detection and Ranging (LiDAR) and spectral datasets were collected using a tripod-mounted laser scanner and a portable spectroradiometer (350nm-2,500nm), respectively. These datasets were subjected to rigorous statistically based data reduction methods to maximize their separability. LiDAR point clouds were filtered using pre-defined local elevation thresholds to remove non-ground points, and reflectance spectra were filtered to remove wavelength bands not significantly contributing to a binary presence/absence disturbance classification in training data.

Filtered LiDAR data reveal distinctive burial footprints, expressed as subtle depressions that are especially apparent in elevation change images and range from -10cm–0cm. Elevation loss is most pronounced directly over buried human bodies due to the redistribution of mass from decomposition, in addition to normal soil settling. Unsurprisingly, these depressions fill in with debris over time, resulting in diminished visibility; however, the two largest burials were still clearly visible in LiDAR data collected at 22 months post-burial.

Statistical analysis of spectra reveals separation in the visible and infrared regions of the spectrum. A Discriminant Function Analysis (DFA) results in the correct classification of 60.0% of disturbed vegetation (n=70) and 54.8% of non-disturbed vegetation (n=84) in the spring season and 74.1% of disturbed vegetation (n=54) and 60.8% of non-disturbed vegetation (n=79) in the autumn season using cross-validation. Binary Logistic Regression (BLR) results in the correct classification of 54.3% of disturbed vegetation (n=35) and 76.2% of non-disturbed vegetation (n=42) in the spring season and 55.6% of disturbed vegetation (n=27) and 74.3% of non-disturbed vegetation (n=39) in the autumn season using a separate validation sample. It is likely that a hybrid statistical model will successfully exploit the high rate of correct DFA disturbance classification and the high rate of correct BLR non-disturbance classification to achieve optimal results. Experimentation with machine-learning approaches suggests they may be useful for reinforcing statistically based predictive models under certain seasonal and technological conditions.

This presentation will demonstrate the importance of using multiple datasets for isolating small or subtle targets when it makes sense to do so, as it does in clandestine human burial scenarios. This presentation will highlight important considerations for these findings, including how ground-based data can be used on its own or in combination with other intelligence and data to inform remote aerial and orbital data collections. Additionally, this presentation will cover some practical ways investigators might use these findings on the ground to facilitate rapid decision making.

Forensic Archaeology, Remote Sensing, Victim Recovery

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