GEOMORPHOLOGICAL FEATURE ENGINEERING AND DEEP LEARNING TO DETECT CRATERS IN LIDAR AND AERIAL IMAGERY, CASE STUDY

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LiDAR and aerial imagery data collected over an area of approximately 80,000 acres were quantitatively analyzed to identify craters and other evidence of munitions use. This approach allowed the rapid and cost-effective analysis of a substantial volume of data without slow, expensive, and potentially unreliable manual reviews. Analysis methods were chosen that would not be sensitive to the occasional presence of vegetation because the provided LiDAR data contained vegetation in the ground response classification in areas of locally steep terrain including craters.

LiDAR data classified as ground response were gridded to generate a high-resolution digital elevation model (DEM). This model was then screened to highlight small, local variations in the ground surface using a spatial demedian filter developed for this effort. These local variations were categorized using a threshold on the amount and direction of deviation, so that depressions including those potentially representing craters would be distinguished. These geomorphological features were further analyzed by grouping them into convex hull polygons, and recording the polygon area, perimeter, and percentage of area within the polygon exceeding the selected threshold. The geometric characteristics of the polygons were then used to filter crater-like depressions from channels associated with drainage. A greedy heuristic algorithm was developed to determine if remaining crater-like polygons were closed features that drained internally, or open features with external drainage.

The DEM and aerial imagery were further analyzed using neural network object detection software to explore the effectiveness of these tools in identifying munitions craters. We used a state-of-the-art real-time object detector neural network that was initially trained on the Microsoft common objects in context (COCO) dataset, which does not contain any craters. We provided the neural network with additional training data from images of site-specific craters as well as artificially generated images and rescaled images. The model performance was compared to and combined with the quantitative analysis approach.