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LiDAR: A Multi-Application Management Tool

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Abstract

The amount of information contained within LiDAR is enormous as to its potential. Applications and management objectives that a single LiDAR dataset can address span everything from natural resources to fire research to archaeology. This presentation will discuss the LiDAR acquired for Mammoth Cave National Park, initial processing methods and derived products (to date). Different algorithms were deployed depending on the intent of the management objective. Natural Resources wanted to expand their polygon vegetation dataset, creating a 3-D vegetation map. Fire Management wanted to quantify the fuel loading across the park; therefore a baseline fuels map was developed. Cultural Resources wanted to identify areas with potential historic anthropogenic remnants; therefore an extensive Digital Elevation Model (DEM) was developed. When one dataset was discussed and developed, more questions were asked of the data. Tools, models, and algorithms exist, facilitating one LiDAR dataset to meet multiple management objectives.

Introduction

Remote sensing technologies have the capability to provide large amounts of information over a given spatial extent. Light detection and ranging, also known as LiDAR, is one such remote sensing technology. Although an in depth discussion of how LiDAR works is beyond the scope of this paper a brief explanation is merited. Identification of features relies on the creation of a rich dataset containing x, y and z values. LiDAR provides an ideal technology for creating such a rich dataset by creating a point cloud (each point representing a single set of x, y and z values). Unlike aerial photography however, LiDAR has the ability to pierce though the vegetation canopy as well as various stories within the canopy and beyond. LiDAR relies heavily on GPS and our understanding of the speed of light. As such, we are able to locate a platform, such as an airplane in the case of this dataset, within three dimensional space and then calculate where a pulse is returning from by using the speed of light.

Therefore the amount of information contained within LiDAR is enormous and so too is its potential. Management applications span a broad range from archaeology to natural resources to fire management. This paper discusses the LiDAR acquired for Mammoth Cave National Park, initial processing methods, derived products to date and future goals. Different algorithms were used depending on the intent of the management objective. Natural Resources wanted to improve upon existing vegetation datasets therefore a land cover classification dataset was created. Fire Management wanted to quantify the fuel loading across the park; therefore a baseline fuels map was developed. Cultural Resources wanted to identify areas with potential historic anthropogenic remnants; therefore an extensive Digital Elevation Model (DEM) was developed.

Data

The LiDAR data was funded by the Joint Fire Science Program and acquired from Mammoth Cave National Park via North Carolina State University. It consisted of derived point data and orthorectified aerial photos. LAStools was used to extract information about this dataset. Data was classified into four classes: unclassified, ground, high vegetation and low point (noise). Data was obtained on December 4, 2010 thereby reducing interference from the forest canopy. Ancillary data in the form of park boundaries, soil, geology, vegetation, and hazards was retrieved via Mammoth Cave National Park and the Kentucky GIS Clearinghouse.

Processing Methods

In order to process the LiDAR data a variety of software was employed and compared in order to determine their capabilities. As noted above, the point cloud had already been classified, but another classification algorithm, by Evans and Hudak called MCC-LIDAR, was also run on the point cloud. This was useful for two primary reasons. First, this allowed for comparison between two different algorithms. Second, proprietary algorithms are generally not fully disclosed which means that research might be conducted with little to no understanding of the classification method used. By comparing the proprietary results obtained from using Toolbox for LiDAR Data Filtering and Forest Studies (Tiffs) and open source results from MCC-LIDAR, a sense of the capabilities of each algorithm could be ascertained. This being said, the results obtained from Tiffs were much more useful due to the relative lack of noise, in the form of pocking, which was evident in the MCC-LIDAR DEM.

Derived Products

Thus far there have been three sets of products derived from the data including a fuel loading database, downed trees map, land classification map and detailed DEM. A fuel loading database was created from downed logs found within the LiDAR data. Land classification was done through combining many variants of the LiDAR data to other imagery data allowing for a highly detailed heterogeneous map. In addition, a highly detailed DEM selected from different surfaces generated using various algorithms. As a result, this highly detailed DEM allowed for archaeological prospection and the identification of potential areas of interest for cultural resource managers.

Future Goals

In the near future we hope to expand our primary applications to the dataset for the rest of the park and collaborate on other applications.