Public Abstract

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Airborne Laser Detection and Ranging (LIDAR) data has a wide range of applications in agriculture, archaeology, biology, geology, military and transportation, etc. LIDAR data consumes hundreds of gigabytes in a typical day of acquisition, and the amount of data collected will continue to grow as sensors improve in resolution and functionality. LIDAR data classification and compression are therefore very important for managing, visualizing, analyzing and using this huge amount of data.

The objectives of this dissertation are (1) to develop LIDAR classification schemes that can classify airborne LIDAR data more accurately without some features or training data that existing work requires; (2) to explore lossy compression schemes that can compress LIDAR data at a much higher compression rate than is currently available.

We first investigate two independent ways to classify LIDAR data depending on the availability of training data: when training data is available, we use supervised machine learning techniques such as support vector machine (SVM); when training data is not readily available, we develop an unsupervised classification method that can classify LIDAR data as good as supervised classification methods. Experimental results show that the accuracy of our classification results are over 99%. We then propose two new lossy LIDAR data compression methods and compare their performance: a wavelet based compression scheme and a geometry based compression scheme. Our new geometry based compression scheme classifies data first then uses different methods to compress different type of LIDAR data (e.g., trees, buildings, ground). Experimental results show that compared to existing LIDAR lossy compression work, our geometry based approach achieves two orders of magnitude lower bit rate with the same quality, making it feasible for applications that were not practical before. The ability to store information into a database and query them efficiently becomes possible with the proposed highly efficient compression scheme.