Performing LiDAR data point reduction using hyperspectral imaging

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Abstract

Light Detection and Ranging (LiDAR) is a technology that uses beams of light to collect 3-D coordinate data of the terrain of an area. This technology is used in many applications, ranging from forestry to automated vehicles. The raw data collected is often composed of millions and possibly billions of points in what is called a point cloud, leading to large file sizes and longer runtimes for any processes involving it. Because of this, reducing the amount of points in each file is necessary for ease of use by anyone. This paper delves into finding a way to incorporate hyperspectral imagery in the reduction process of LiDAR point clouds. This is accomplished by first acquiring hyperspectral and LiDAR data for an area, creating a landuse/landcover classification map using an Artificial Neural Network, performing an accuracy assessment of the classification, and then utilizing the final classification to guide reducing the LiDAR points by terrain complexity. This study seeks to find a new method for LiDAR point cloud reduction to make the files easier to use for the general public.

Study Area and Data

City of Cedar Falls, IA
Population: 39,387 (2011 census)
Area: 28.75 mi^2

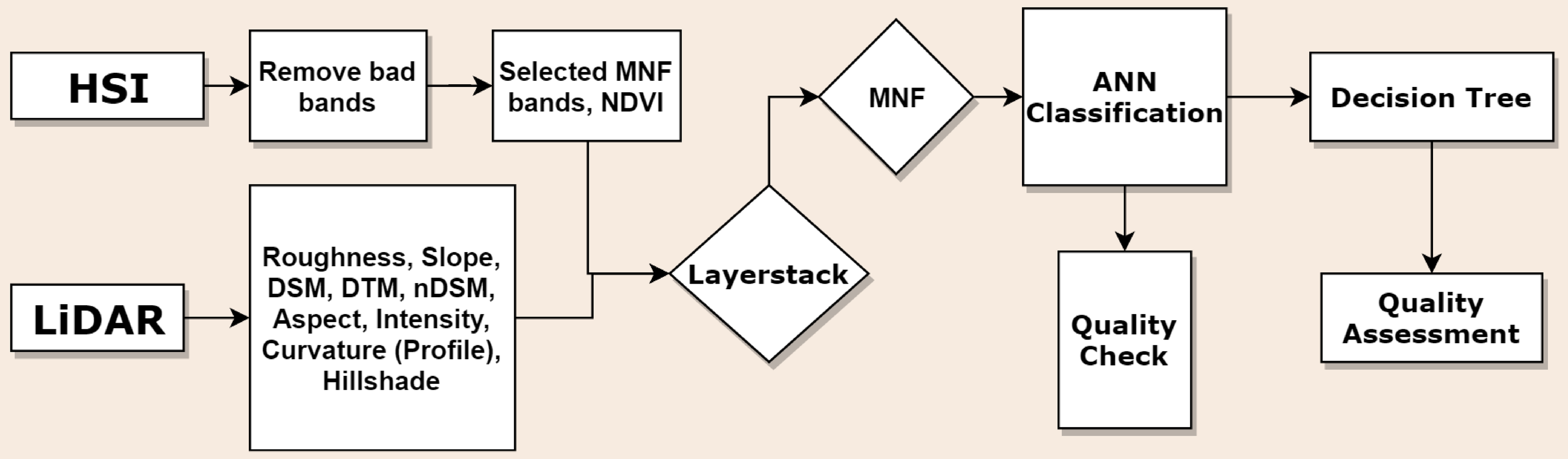
Data	Source
Lidar	University of Northern Iowa GeoTREE site (http://www.geotree.uni.edu/en/)
Hyperspectral Imagery (HSI)	2009 AISA Aerial Imagery from Galileo Group, Inc. *(Pictured above)* Collected April 22nd, 2009. 359 bands, V-NIR (400-1000nm) and Mid-IR(10,000-17,000nm). 2m spatial resolution.
Aerial Photo	Iowa State GIS Facility

Research Goals and Objectives

To explore how hyperspectral imagery can be used to optimize the LiDAR point cloud reduction process:

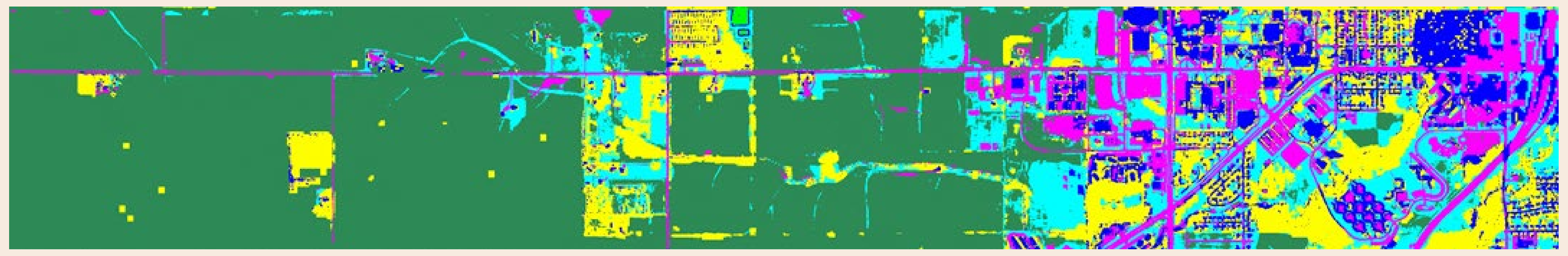
- To generate a detailed land use/cover map from AISA hyperspectral imagery using the Artificial Neural Network (ANN) algorithm;
- To use the derived classification map to filter LiDAR Point clouds by the decision tree process.

Methodology



Workflow Diagram

Results



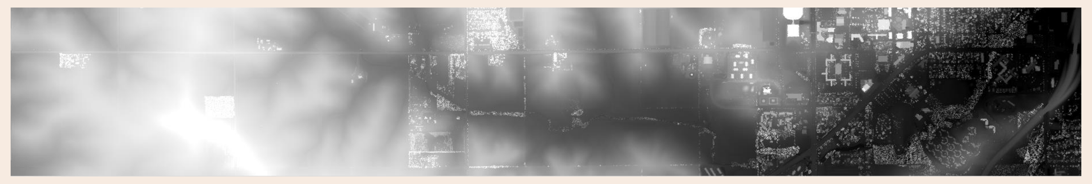
Classes	Accuracy	# of points checked
Water	100.00%	4
Built	87.88%	60
Grass	55.43%	63
Forest	68.89%	54
Roads	69.49%	51
Agriculture	92.31%	131
Overall Accuracy	**76.03%**	**363**

Nth pixel filtered per class

#	Water	Built	Grass	Forest	Roads	Agriculture	RMSE
1	2	2	2	2	2	2	1.537
2	2	20	4	20	3	2	2.214
3	2	200	4	40	4	2	2.757
4	2	300	4	60	15	2	2.232
5	2	400	4	120	50	2	2.306
6	2	500	4	500	50	2	2.349
7	2	1000	4	1000	100	2	2.414
8	2	5000	4	5000	100	2	2.503
9	20	20	20	20	20	20	2.135
10	500	500	500	500	500	500	2.637

Results

Filtered DEM 10



Filtered DEM 1

Conclusions / Future Direction

ANNS are a fast and accurate way to produce a classification map

- Classification accuracy would have improved if clumping had not been performed
- Areas where hyperspectral imagery had gaps and only LiDAR data was present were not as accurate in classification.
- Profile curvature on building edges may have contributed to inaccuracy–edges of buildings were classified as forest.

Classification maps are an effective way to guide LiDAR point cloud filtering

- A more accurate classification would have produced a more accurate result.

Currently, Classification map accuracy is in the process of being improved.

Instead of filtering by every Nth point, future tests will filter randomly within each class to get a less stratified result. Currently a python script to accomplish this is in the process of being written.

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