Factsheet # 1

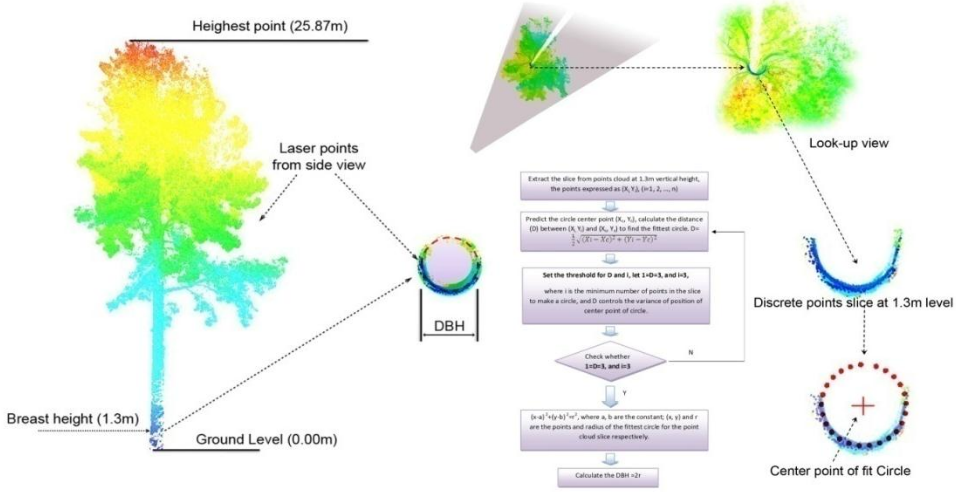
Forest Inventory and Stem Characterization from Terrestrial LiDAR

This research was funded by the NSF Centre For Advanced Forestry and the UW Precision Forestry Cooperative

UW

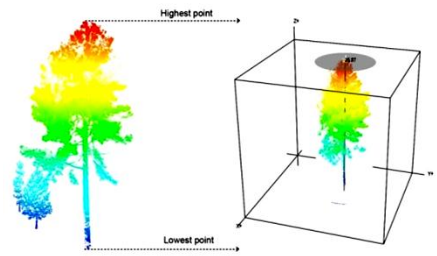
Understanding multiscale dynamics of landscape change through the application of remote sensing & GIS

Remote **S**ensing & **G**eospatial **A**nalysis **L**aboratory



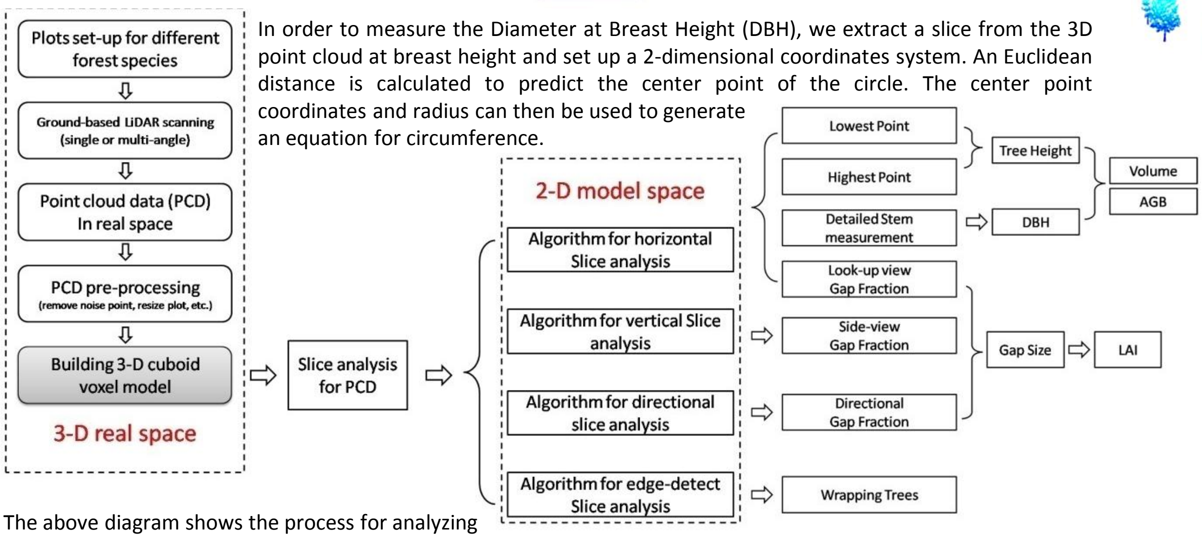
Specifications for the UW Arboretum/CUH terrestrial LiDAR data

Date of acquisition	September 20th, 2007
Laser sensor	Leica HDS 3,000
Field of view	360º (horizontal) 270 º (vertical)
Laser wavelength	Visible green light (532m)
Laser spot size	4mm (calibrated at 50m)
Laser pulses/second	1800 lasers/s



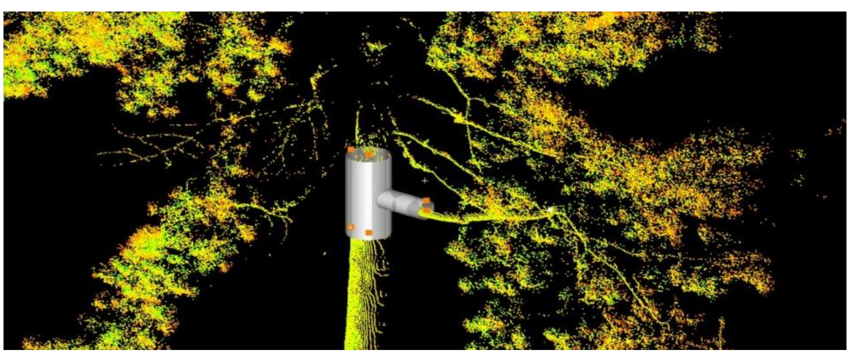
Tree height and crown ratios from terrestrial LiDAR data using FUSION

In order to measure the Diameter at Breast Height (DBH), we extract a slice from the 3D point cloud at breast height and set up a 2-dimensional coordinates system. An Euclidean distance is calculated to predict the center point of the circle. The center point coordinates and radius can then be used to generate an equation for circumference.



The above diagram shows the process for analyzing LiDAR data. Traditional forest inventory characteristics DBH are useful in estimating ecosystem level variables such as above ground biomass.

The volume of trees in the LiDAR point cloud are predicted using the volume functions of Laasasenaho (1976, 1982). The parameters of the functions have been estimated for the following tree species: pine, spruce, birch, aspen, alder, and Siberian larch. Models for pine or birch are used for other coniferous and broad-leaved tree species respectively. The explanatory variables of the models are (measured) DBH, upper diameter, and height.



Modeling techniques can be used to reconstruct trunk characteristics where data might be sparse or missing, these methods generate information on stem architecture suitable for physiological and wood quality applications. Above image: Pipe model fitted to a Ponderosa Pine.

Compared with the low laser pulse intensity and multi-returns of aerial based LiDAR, terrestrial LiDAR emerges as new remote sensing technology, with extremely high density of laser returns but just one return for each laser pulse. Terrestrial LiDAR shows the capacity to capture more detail of forest 3D structure. More research on algorithm development is crucial.

Forest architecture information greatly affects the radiation regime within the canopy, biochemical and ecological process such as photosynthesis, radiation transfer within canopy, evaporation, transpiration. In order to get best understanding about the role of forest ecosystem in climate change, carbon and water cycling, we need to focus on forest structure and architecture. Forest vertical structure information, some biophysical processes in leaf-level, forest dynamic change and growth are all needed. Comparisons between phase and time of flight laser scanners are also required.

Overall, terrestrial LiDAR demonstrates promise for objective and consistent forest metric assessment further work is needed to refine and develop automatic forest inventory feature extraction techniques.

THE ISSUE: Forest inventory is the basis and foundation for sustainable management of a forest ecosystem. This involves the measurement of the extent, quantity, quality, or even diversity condition of forest in a defined area. Field based forest inventory is time-consuming and labor-extensive, it is often impractical to complete census by measuring every tree. We present examples of obtaining forest characteristics from terrestrial LiDAR data.

THE KEY QUESTION:

Will terrestrial LiDAR replace traditional forest inventory methods? Not any time soon, but LiDAR can supplement the information we collect on the ground.

Citation: Moskal., L. M. and G. Zheng, 2008. *Forest inventory and stem characterization from terrestrial LiDAR.* Factsheet # 1. Remote Sensing and Geospatial Application Laboratory, University of Washington, Seattle, WA. Digital version of the fact sheet can be downloaded at: http://dept.washington.edu/rsgal/