LiDAR Applications

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Examples of LiDAR applications

- forestry
- hydrology
- geology
- “urban” applications

Forestry applications

- canopy heights
- individual tree and crown mapping
- estimated DBH and leaf area index (based on correlation with tree height or crown diameter)

Example #1: forestry applications

"Use of airborne LiDAR and aerial photography in the estimation of individual tree heights in forestry"

Juan C. Suarez et. al., Computers and Geosciences, 2005

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Study area

- Aberfoyle forest district, Scotland
- Sitka spruce
- 4 LiDAR pulses/meter^2
- 20 km^2 study area

Methodology

- generated a tree canopy model (TCM) by subtracting the bare earth LiDAR DEM from the first return DSM
- combined the TCM with digital aerial photos (band seperated RGB)
- delineated combined TCM/RGB image into individual tree top polygons using eCognition feature extraction software

DEM LiDAR Filtering: Local Minima

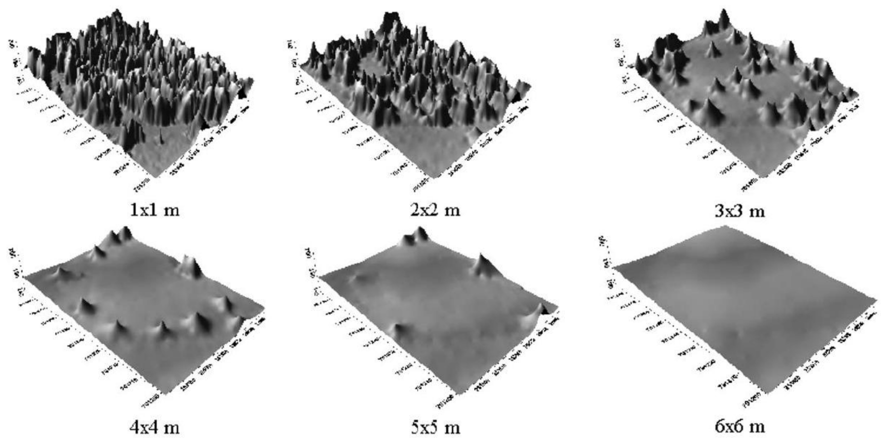

Fig. 6. Filtering process of spurious ground hits is obtained by local minima in an iterative process using variable kernel sizes. Example obtained from plot 9 in Aberfoyle.

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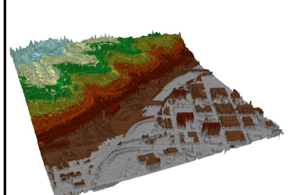

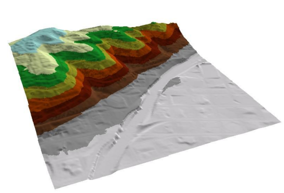

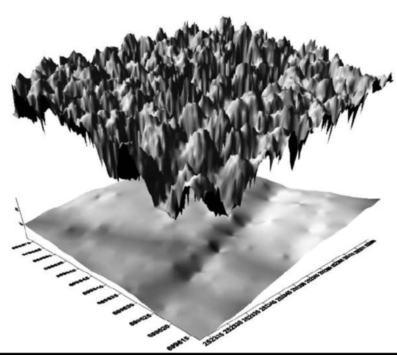

Methodology

- eCognition uses *scale* and *homogeneity* parameters obtained from the combined digital image to “segment” the image into geographic features
- *scale* refers to the minimum size required to identify a particular object
- *homogeneity* is an interaction between the color and shape of objects in the image (texture)

Methodology

- the TCM image was weighted 5 times more than each of the visble aerial bands in order to stengthen the influence of elevation on the canopy delineation
- the resulting tree top polygons were assigned a height value using a simple “local maximum” technique

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Results

- Only a small portion of LiDAR pulses pass through canopy to reach the ground; sampling must be dense to acquire a good bare earth DEM (6-10 returns per tree crown)

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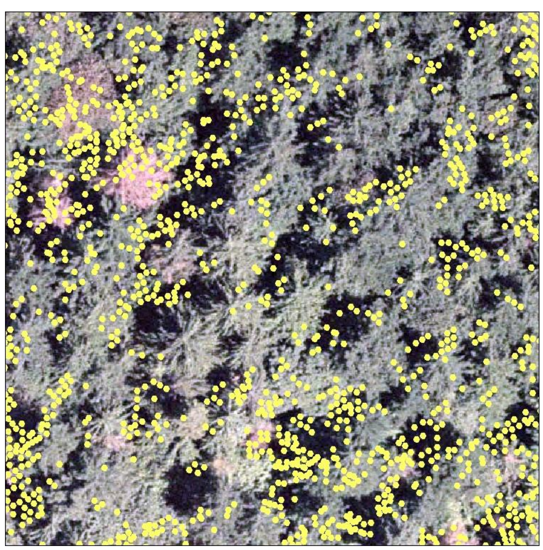

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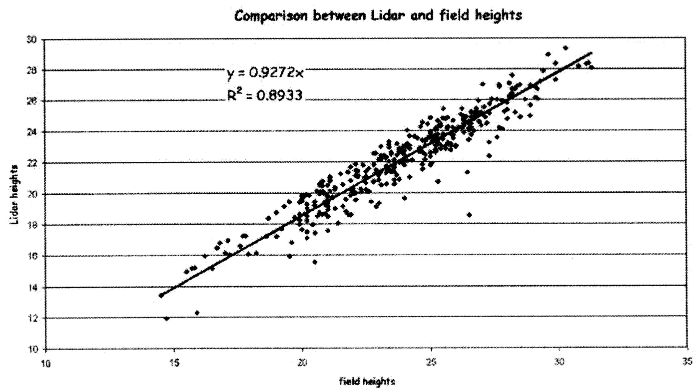

Fig. 9. Tree height recovery model.

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Results

- 75% of tree heights were predicted within 1 m, 91% within 1.5 m and 96% within 2 m.
- results consistent across DBH distribution
- LiDAR typically underpredicted tree heights by 7 to 8%

Example #2: forestry applications

"Isolating individual trees in a savanna woodland using small footprint LiDAR data"

Qi Chen et. al., *Photogrammetric Engineering and Remote Sensing, August 2006*

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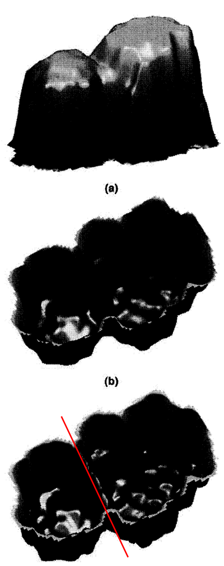
Study area

- Ione, California
- oak savanna
- 10 LiDAR pulses/meter

Methodology

- identified tree top points by searching for the maximum height in a variable "window" of DSM pixels
- window size determined using the relationship between crown size and tree height in the study area forest (mimimum predicted value)
- area around tree top points "segmented" into tree crowns using a watershed delienation technique



Results

- 64% of trees were succesfully “isolated”
- problems identifying arge oak trees with irregular, complex branch structure (branches can look like individual trees, or “valleys” between trees not discernable)

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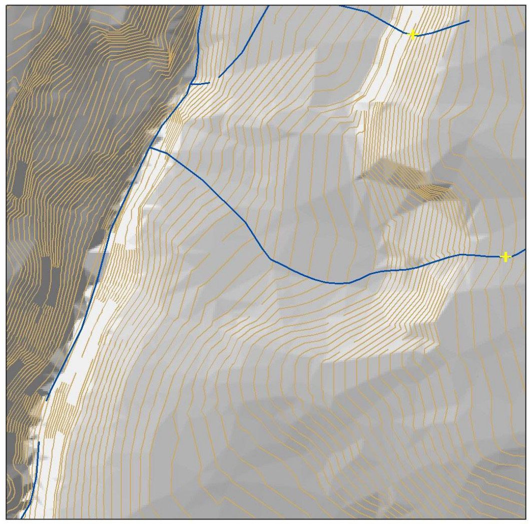
Hydrology applications

- stream mapping
- watershed delineation
- floodplain mapping
- runoff/pollution prediction
- bathymetry



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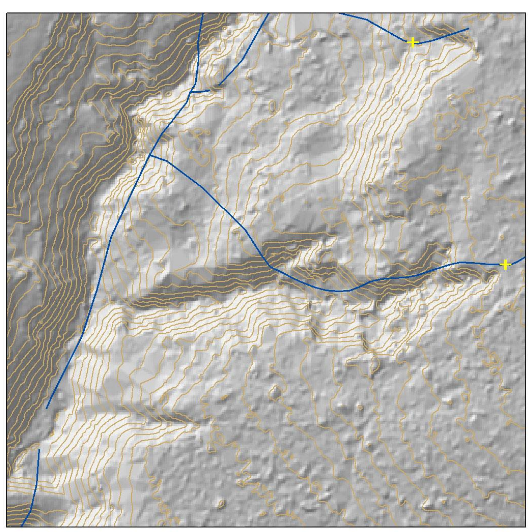

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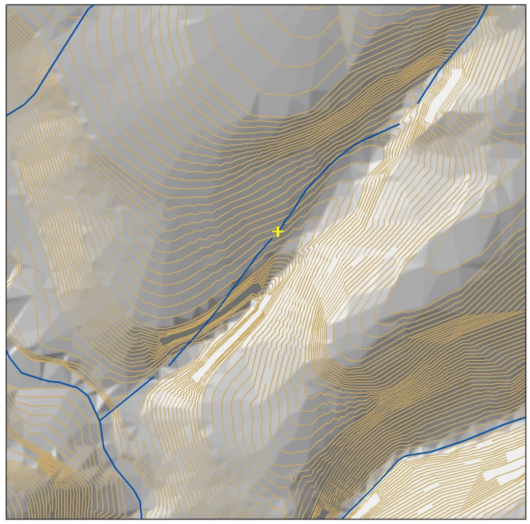

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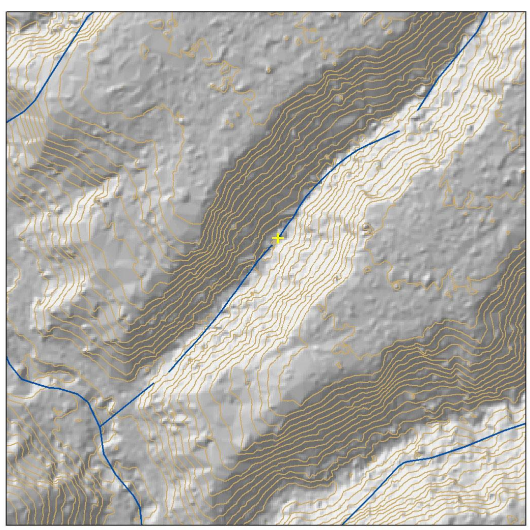
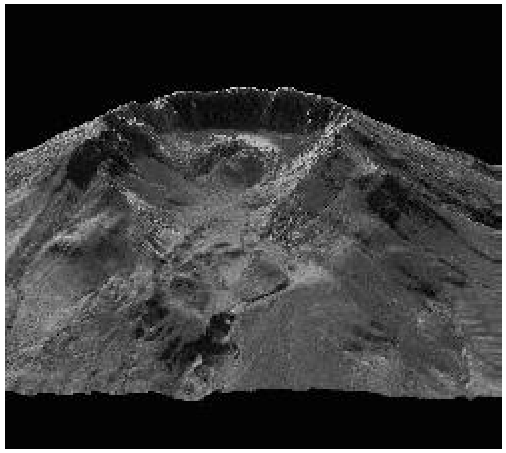


Geology applications

- landslide mapping
- fault mapping
- surface morphology and movement
- glacial morphology and movement

Example: geology applications

"U.S. Geological Survey (USGS) and NASA scientists studying Mount St. Helens are using high-tech Light Detection and Ranging (LIDAR) technology to analyze changes in the surface elevation of the crater, which began deforming in late September 2004"



Urban applications

- building heights and footprint extraction
- street tree mapping
- viewshed analysis
- shadow impacts

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Example: “urban” applications

“DEM generation and building detection from LiDAR data”

Ruijin Ma, Photogrammetric Engineering & Remote Sensing, July 2005

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Methodology

- used a 3 X 3 pixel window to identify “smooth”, or planar surfaces on the DSM
- planar surfaces assumed to represent building roofs rather than trees and shrubs
- planar building surfaces extracted into building polygons

Methodology

- small, ragged building polygon segments regularized into parallel and perpindicular lines using a method developed in this study

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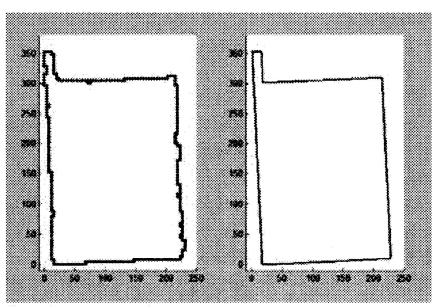

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Results

- 80% of buildings were correctly detected
- buildings mostly obscured by trees could not be identified
- buildings with curved or arched roofs could not be identified

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