Visualization, storage, analysis and distribution of **massive** aerial LiDAR point clouds

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AHN²: A dataset covering totally the Netherlands



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AHN²: A tiled dataset

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- 1 Real-time visualisation
- **2** Storage + spatial analysis
- 3 Distribution of such datasets

Can our tools/workflows scale to **Massive** datasets?

Real-time Visualisation

- Because it's a nice challenge!
- Because we need to:
 - Perform visual inspection of raw measurements
 - Gain insights from numbers

Rendering \rightarrow Visualisation \rightarrow Interaction

From DEM terrain...



(AHN² DEM 0.5m grid)

... to point cloud



(\sim 2 millions points from AHN²)

OpenSceneGraph

- most popular FOSS scene graph engine
- based on flight-simulator software (not GIS)
- OpenSceneGraph-based VRMeer software
- Python abstraction layers http://code.google.com/p/osgswig

Demonstration video





Multi-resolution data struture



Multi-resolution data struture



LOD effects



- Stereoscopic display
- 3D interaction with space-mouse, Wii balance board interaction
- More info: PhD thesis Techniques and Architectures for 3D Interaction, Gerwin de Haan, TU Delft, 2009.





Analysis & Storage

LiDAR datasets are formed by scattered points in 3D space, which are the samples of a surface that can be projected on the horizontal plan.





Original LiDAR points



Raster representation



Raster representation



Original LiDAR points



TIN (with Delaunay triangles)



TIN (with Delaunay triangles)



TIN (with Delaunay triangles)

- Goes beyond the usual "store points and edges/triangles"
- Ideas come from data structures for compression of graphs



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Stars in a DBMS

ID	X	у	Z	star
1	3.21	5.23	2.11	2-44-55-61-23
2	5.19	29.01	4.55	7–98–111–233–222
3	22.43	15.99	8.19	99–101–73–23
5674	221.19	15.23	37.81	309-802-793-1111

Advantages:

- **1** Only one table with id x y z star
- 2 No spatial index needed: fetching of triangles based on "walking"
- 3 Star column need not be filled (\sim Simple Features)
- 4 Local updates are possible (insertion and removals)
- Ideas are readily extensible to 3D for storing manipulating tetrahedra

Point Location = "Walking" in the triangulation



(Can be made efficient with some tricks [MSZ99])

Range Queries: also uses the triangulation





Figure from Martin Isenburg's presentation at GIScience 2006 [ILSS06]

Distribution of the Data



Velas3D: An online AHN² selector



http://gw.vrlab.tudelft.nl/3dve/client

Velas3D: An online AHN² selector



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Velas3D: An online AHN² selector



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