Lecture 14:
Three Dimensional Mapping and Modeling
3D measurement systems: remote sensing of objects

- First generation DEMs, photogrammetry and contour conversion
- Second generation based on SAR and IFSAR
- SRTM near global coverage, 30m/90m
- NED completed at 30m, then 15m and less
- LIDAR has now taking over
- New SfM photogrammetric methods showing promise
Photogrammetry
Interferometric Radar
IFSAR DEMs
SAR from Space

\[ R = \text{Time delay}/2 \times \text{Light Vel.} \]
SRTM: Global topo map
How Lidar works
LIDAR first and last pulse
LIDAR terrain detail
LiDAR at El Pilar
Terrestrial Scanning LiDAR
Campus scans

Terrestrial LiDAR
Campus Scan - May-21-2009

map & data processing by Bodo Boekhagen, Geography Department
Lidar Point Cloud Data
UCSB Ellison Hall, 1st Floor

Secondary Study Area
EH Lobby

Primary Study Area
EH Room 1720

Additional Study Areas
North Wing Hallway
East Wing Hallway
East Stairwell

Data Collection Information
Platform: Riegl LMS-Z420i
Laser Scanner
# Points: 35 million
Lidar Point Cloud Data
EH East Stairwell, 1st/2nd Floors
Platforms Tested To Date (EH Room 1720)

Nikon D3100 (14.2 MP)
Microsoft LifeCam Studio (2.1 MP)
Logitech QuickCam Deluxe (0.3 MP)
Sony DSC-TX10 (16.2 MP)
Panasonic DMC-FZ8 (10.1 MP)
Riegl LMS-Z420i Laser Scanner (Baseline Measurements)
Animated Point Cloud (LifeCam Studio)
Sample 3D Point Cloud via Webcam

Camera: Microsoft LifeCam Studio
(1920x1080)

# Stations: 48 around room perimeter

# Images: 144 HDR images

# Points: 18.3 million
3D modeling and data structures

- Longley et. al. 6 models: gridded points, irregular points, cells, irregular polygons, TIN and contours
- Prior dominance of DEM
- Extensive use of TIN and surface patches
- Computer graphics and games favor Voxels
- LIDAR and photogrammetry return a POINT CLOUD
- Has led to use of term Digital Surface Model
Measurement vs. Modeling

- Select key surface points, edges
- Generalize remaining surfaces
- Solids modeling
- Feature extraction; Buildings, trees (e.g. Lidar analyst, Feature analyst, Quick Terrain modeler, TerraSolid (Microstation))
- Geometric vs. natural objects
- Realism vs. Size e.g. Google Object Warehouse
LiDAR building extraction
Simple 3D Model built by extrusion
BingMaps 3D Selected Cities (LA)
Simplest 3D tool: Sketch-Up (KML)
3D Buildings/Flat trees
Polygon extrusion (ArcScene)
Kinect, Skanect and Meshlab for 3D Reconstruction of Building Interiors: Kevin Wengler (threedeemeedia.org)
Integrated SfM, photogrammetry and LIDAR
Software (See: wiki entry)

- 3dsmax
- AC3D
- Ayam
- AOI
- Blender
- Carrara
- Cheetah 3D
- Cinema 4D
- CityEngine
- Cobalt
- Electric Image Animation System
- Form-Z
- Houdini
- Hypershot
- Hypermove
- Lightwave3D
- MASSIVE
- Maya
- Modo
- plugin3D
- POV-Ray
- Pro/Engineer
- Quest 3D creative
- Quest 3D Power
- Quest 3D VR
- Relux Professional
- Rhinoceros 3D
- Silo
- SketchUp/Pro
- Softimage
- Solid Edge
- solidThinking
- SolidWorks
- Swift3D
- trueSpace
- ViewBuild3D
- VR4MAX
- Vue
- ZBrush
3D standards for Geospatial data

- VRML and GeoVRML
- X3D and OGC, Geospatial component and X3D Earth (e.g. Planet9 London)
- OGC CityGML
- Web3D Service
- LandXML.org
- COLLADA /KML (SONY, Google)
- National 3D-4D-BIM Program (USGSA)
- 3DVIA (Bing Maps)
3D in Geobrowsers

- Picture and panorama inclusion
- Google streetview
- GoogleEarth 3D Buildings and terrain
- Bing Maps 3D and oblique views
- Microsoft Photosynth
- Most geobrowsers include topography
Virtual Reality: The Allosphere
Projected images
Augmented Reality
Kite Photogrammetry; Kitty Currier
Agisoft Photoscan
Centimeter resolution: Gigabyte files, need GPS tie points
Kite photogrammetry

For more information see Mapping with strings attached: Kite aerial photography of Durai Island, Anambas Islands, Indonesia (Journal of Maps, 2014).

Figure 3. (a) Locations of 38 ground control points relative to mosaic’s extent. (b) Estimated camera positions for 357 images, superimposed on a map of image density.
How to generate images?

- Need many images from different angles
- Overlap creates stereo model
- Agisoft Photoscan then extracts model and assigns point cloud with color
- Can process with Meshlab, CloudCompare, other software
- Our answer: Drone (Quadcopter)
Phantom 4 with collision avoidance

- Scans height by IR sensor
- Position using GPS
- Fully gimballed camera
- Can be programmed to collect video or interval images
- 20 minutes of flight with rechargeable batteries
- Flight planning software, smartphone or tablet piloting
Mapping Ellison 1612
Image capture
Point Cloud
This is not a photograph
A 3D model from scratch
Closer to home
Summary

- Development of direct 3D mapping technologies
- LiDAR still the gold standard
- Both airborne and terrestrial
- Creates point clouds and DSMs
- Can map buildings and interiors, true 3D
- Standards and browser compatibility
- Many new low cost methods, kites, balloons, drones
- Processing via SfM software, e.g. photoscan
- Expect a great deal more 3D!