The Alabama Association of Assessing Officials

LiDAR
(Light Detection and Ranging)

Presentation Objectives

- **Focus**— What is LiDAR?
- Discussion Areas:
  - How does LiDAR work?
  - Types of LiDAR
  - Terminology
  - Benefits of LiDAR

HOW DOES LIDAR WORK?

National Ecological Observatory Network. November 6, 2014. How Does LiDAR Remote Sensing Work? Light Detection and Ranging [Video file]. Courtesy: Battelle. Retrieved from https://youtu.be/EYbhNSUnIdU.

How does LiDAR work?

- LiDAR instruments can rapidly measure the Earth's surface.
- Some systems can send more than 1,000,000 pulses per second.
- Result is a densely spaced network of elevation points used to generate a three-dimensional representation of the Earth's surface and its features.

TYPES OF LIDAR

Types of LiDAR

- There are two basic types of LiDAR
  - Airborne
  - Terrestrial

Types of LiDAR

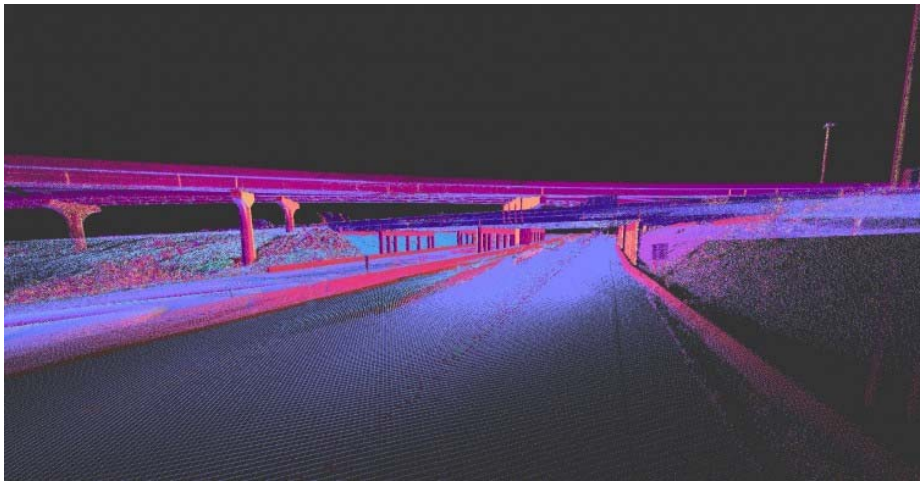
- Airborne LiDAR
  - System installed
    - Fixed-wing aircraft – most common and cost effective
    - Helicopter – higher accuracy over larger areas and air density/pollutant measurements
  - Two types of Systems
    - Topographic LiDAR
      - Used to derive surface models for use in survey assessments, forestry, or urban planning
    - Bathymetric LiDAR
      - Acquisition that is water penetrating

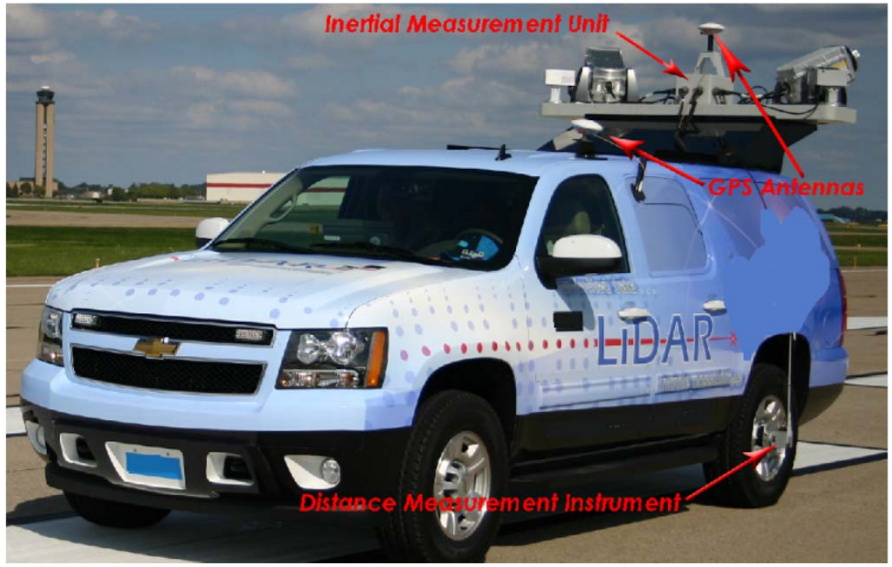
Types of LiDAR

- Terrestrial LiDAR
  - Collects very dense and highly accurate points, which allows precise identification of objects
  - Two types
    - Mobile
    - Static

Types of LiDAR

- Terrestrial LiDAR
  - Mobile
    - Mounted on a moving vehicle

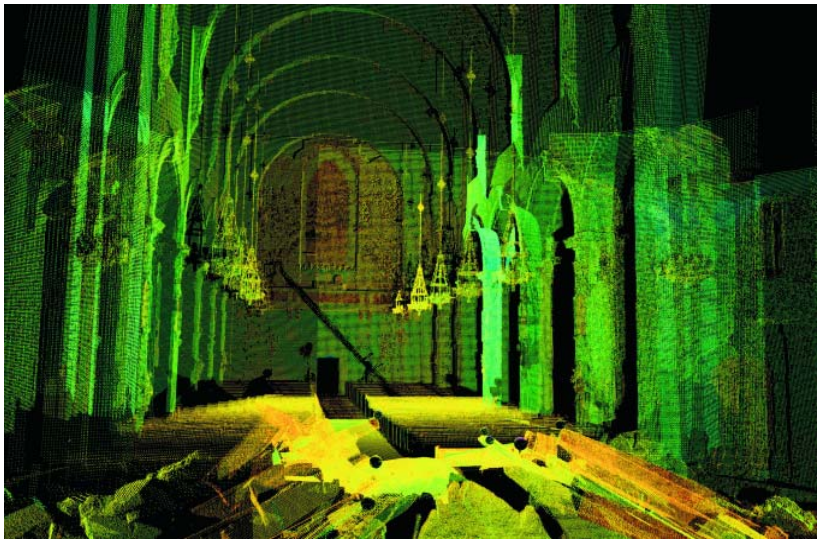


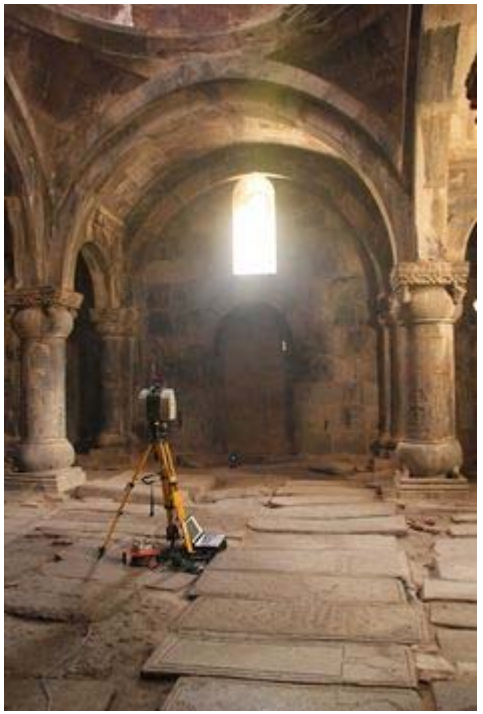


- Analyze road infrastructure
- Locate encroaching overhead wires, limbs, etc.

Types of LiDAR

- Terrestrial LiDAR
  - Static
    - Mounted on a tripod or stationary device
    - Used to develop point cloud for mining, archaeology, etc.

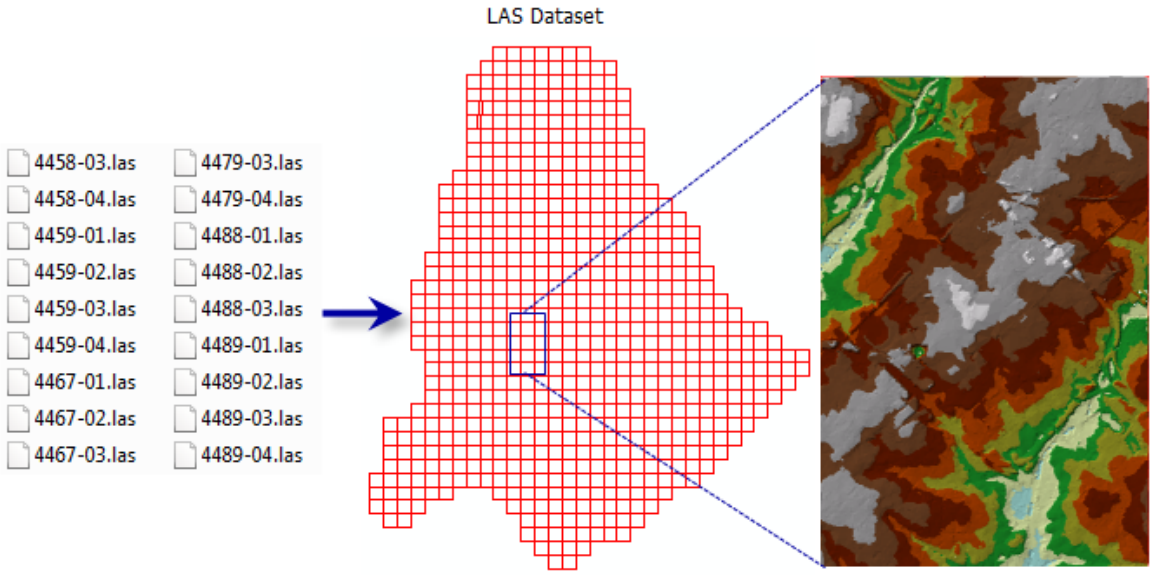




TERMINOLOGY

Terminology

- LAS (Laser file format)
  - Binary file format for the exchange of 3-dimensional point cloud data between data users.



http://desktop.arcgis.com/en/arcmap/10.3/manage-data/las-dataset/what-is-a-las-dataset-.htm

Terminology

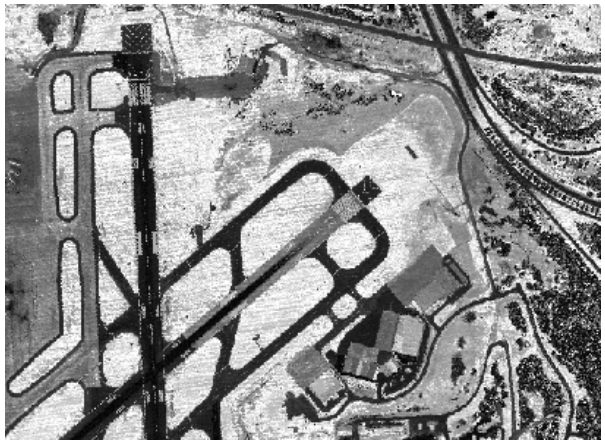
- RMSE (Root Mean Square Error)
  - A statistical measure that quantifies the level of error in the data.
  - Measures how much error there is between two datasets comparing a predicted value and an observed or known value.

RMSE Formula:

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \hat{x}_i)^2}$$

Terminology

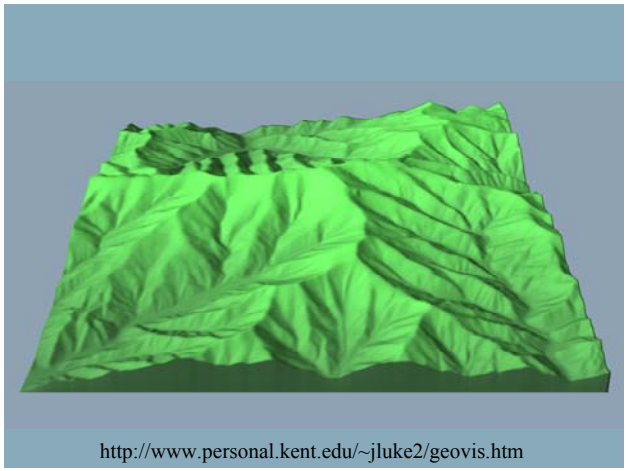
- Intensity Data
  - The measurement of the strength of the return from the laser.
  - Values represent how well the object reflected the wavelength of light used by the laser system.
  - Resemble a black and white photo.



http://desktop.arcgis.com/en/arcmap/10.3/manage-data/las-dataset/what-is-intensity-data-.htm

Terminology

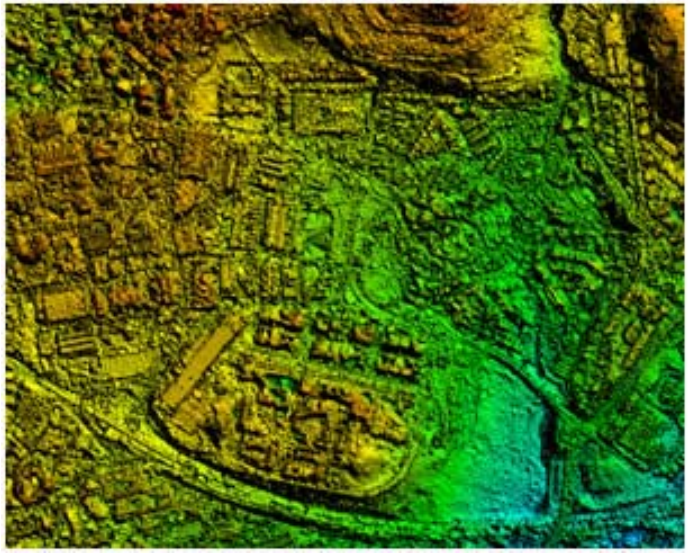
- DEM (Digital Elevation Model)
  - The representation of continuous elevation values over a topographic surface by a regular array of z-values, referenced to a common datum.
  - Typically used to represent terrain relief (bare earth)



http://www.personal.kent.edu/~jluke2/geovis.htm

Terminology

- DSM (Digital Surface Model)
  - Elevation model that includes the tops of buildings, trees, and any other objects
  - Only shows ground where there is nothing over it



https://www.geospatialworld.net/article/3d-city-models-for-wireless-network-application/

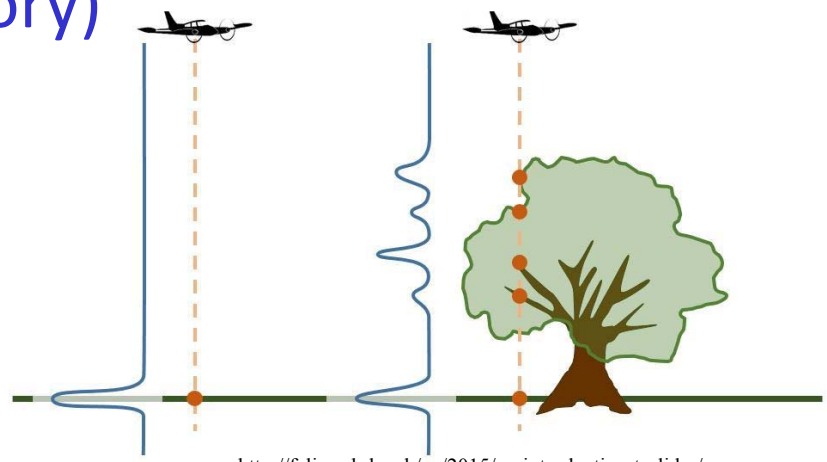
Terminology

- IMU (Inertial Measurement Unit)
  - Used to determine the attitude of the aircraft as the sensor is taking measurements.
  - Used to provide position and orientation for camera shots and laser measurements. (roll, pitch, and yaw)

https://www.e-education.psu.edu/geog481/l1_p5.html

Terminology

- Return Number (First/Last Return)
  - Many LiDAR systems are capable of capturing the first, second, third, and ultimately the “last” return from a single laser pulse
  - Used to determine what the reflected pulse is from (e.g., ground, tree, understory)



http://felix.rohrba.ch/en/2015/an-introduction-to-lidar/

Terminology

- Point Spacing
  - How close the laser points are to each other
    - Equivalent to the pixel size of an aerial image
  - Point spacing determines the resolution of derived gridded products

Point Density	0.5-1 pts/m2	1-2 pts/m2	2-5 pts/m2	5-10 pts/m2	10+ pts/m2
Application	• Basic Surface Model • Forest Inventory	• Flood Modelling • Dam and Water Inundation Calculations	• Multi-purpose data sets	• Basic 3D models	• Detailed 3D city models

http://felix.rohrba.ch/en/2015/point-density-and-point-spacing/

BENEFITS OF LIDAR

Benefits of LiDAR

- Data can be collected quickly with very high accuracy.
- Surface data has a higher sample density. The high sample density improves results for certain applications such as floodplain delineation.
- Ability to collect elevation data in a dense forest, where photogrammetry fails to reveal the accurate terrain surface due to dense canopy cover.

Benefits of LiDAR

- Data can be used to calculate timber areas which could be used when determining current use values.
- LiDAR DEMs can be used for orthorectification.
- Data can be used for building change detection from year to year.
- Coastal change detection.

Sources to Access Current and Future Publicly Available LiDAR Data

§ U.S. Department of the Interior | U.S. Geological Survey (USGS) – The National Map
https://viewer.nationalmap.gov/basic/?basemap=b1&category=ned,nedsrc&title=3DEP%20View

§ United States Department of Agriculture-Natural Resources Conservation Service (USDA-NRCS) - Geospatial Data Gateway
https://datagateway.nrcs.usda.gov/

§ United States Interagency Elevation Inventory
https://coast.noaa.gov/inventory/

§ NOAA Digital Coast – Data Access Viewer
https://www.coast.noaa.gov/dataviewer/#/

Copies of this presentation can be found on the Alabama Department of Revenue website.

THE END