Dots at the DOT

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POINT CLOUD GENERATION
REMOTE SENSING CONCEPTS

- Remote Sensing: *Technique for measuring, observing or monitoring a process or object without physically touching the object under observation.*

- 2 Categories
  - Active Sensor - provides the energy source on which the measurement is based.
    - LiDAR, RADAR, Flash Photography, etc.
  - Passive Sensor - does not include the energy source on which the measurement is based.
    - Eyes, flash less camera, etc.
NOT ALL POINT CLOUDS ARE CREATED THE SAME

- **Point Cloud Creation Methods:**
  - LiDAR *(Light Detection And Ranging)*
    - Active Sensor Based
  - Structure From Motion (SFM)
    - Passive Sensor Based

- **Data Collection Methods**
  - Airborne
  - Mobile
  - Terrestrial
ACTIVE SENSOR BASED POINT CLOUD
LiDAR BACKGROUND

- LiDAR - Light Detection and Ranging
  - Developed in 1960s-70s but impractical to use until the early 90s due to pulse speed and computing power.
  - First used in space as an altimeter for landing.
  - ODOT purchased its first aerial unit in 2004
TYPES OF AERIAL LIDAR

- Linear LiDAR* (Most Common Type)
  - Individual laser beams are used to measure range.
    - Along Tack Scanners (Push broom), Cross Track Scanners (Whisk broom)
  - Advanced data collection techniques like Bathometric LiDAR

- Single Photon and Geiger Mode LiDAR
  - One pulse projected into sub-pulses collected by an array of receivers.

- Flash LiDAR
  - Pulse of lasers (like a flash bulb) collected by an array over a footprint on the ground.
CONCEPT OF TRADITIONAL LIDAR (TIME OF FLIGHT)

- Two properties of laser based systems
  - Laser is monochromatic (specific wavelength of light)
  - Laser Light is directional and focused
- Measures distance to surfaces by timing the outgoing laser pulse and the corresponding return or returns (s).
  - Distance = time*(speed of light)/2
  - Stores the angle at which the laser was fired*
LEVERAGING ADDITIONAL PROPERTIES OF LIGHT

- Multiple Laser Returns From a Single Pulse
TERRESTRIAL LASER SCANNING

- Very similar to Aerial LiDAR
  - Active Sensor
    - Laser (usually NIR -1064nm)
      - Class 1 eye safe
    - Time of Flight
      - Known scan angle
      - Known position
  - Most systems operate like a total station
  - Ability to collect data in dangerous and hard to access areas remotely.
TRADITIONAL LIDAR (TIME OF FLIGHT)
TERRESTRIAL LASER SCANNING

- Advantages of Terrestrial Scanning:
  - Ground based system gives user very precise point cloud data
  - Photos and Lidar are collected simultaneously to create realistic looking data
  - As with aerial systems ability to penetrate through vegetation creates a more accurate elevation model
  - Data set can be used for many different applications (measure reflectivity of objects, heights of objects, terrain models, extract assets)

- Disadvantages of Terrestrial Scanning:
  - Very Large data sets (not as big as Mobile or Aerial) can make downloading and managing data in the field challenging.
  - Labor intensive data processing to remove erroneous points ("noise") from the data set.
  - Limited collection rates based on equipment speed and the need to set-up equipment multiple times.
  - Line of sight limits the range of data collection.
TERRESTRIAL LASER SCANNING EXAMPLE

Dots at the DOT, Point Clouds in the Real World
TERRESTRIAL LASER SCANNING EXAMPLE
PASSIVE SENSOR BASED POINT CLOUD
Structure from Motion is a photogrammetric technique used to estimate 3D structures with 2D photos.
Similar to how stereo vision works
  - Dense Image Matching Algorithms
NOT ALL POINT CLOUDS ARE CREATED EQUAL

Dots at the DOT, Point Clouds in the Real World
TYPICAL POINT CLOUD DELIVERABLES
STANDARD POINT CLOUD DELIVERABLES

- Edited Point Cloud
- Digital Surface Model (DSM)*
  - Less costly, includes vegetation and buildings
- Digital Terrain Model (DTM)*
  - More expensive, edited to only display the terrain

*Typical formats include .tin (triangulated irregular network) or landxml
WHAT IS AN EDITED POINT CLOUD?

- Classification of point cloud
  - “Put on Layers/Levels”
    - ODOT Classification Scheme
      - 1 Default
      - 2 Ground
      - 3 Vegetation-Misc
      - 4 Medium Vegetation
      - 5 High Vegetation
      - 6 Building
      - 7 Low Point
      - 8 High Point
      - 9 Water
      - 10 Bridge
      - 11 Road
      - 22 Model Key Point
TRIANGULATED IRREGULAR NETWORK WITH PLANIMETRIC BREAKLINES AND VOIDS

Generated through a top-down approach.

Used for existing conditions in design.
Mesh Algorithms are able to have multiple Z (elevation values) for the same X,Y coordinate.