Virginia Tech Transportation Institute

LiDAR: Another Potential Data Source

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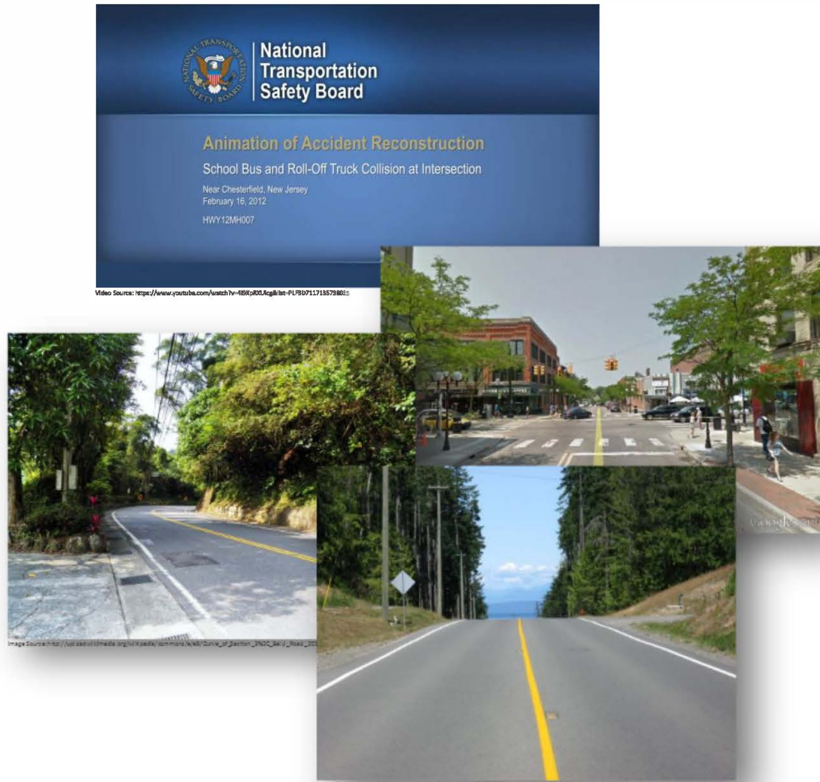
Problems Assessing Visibility

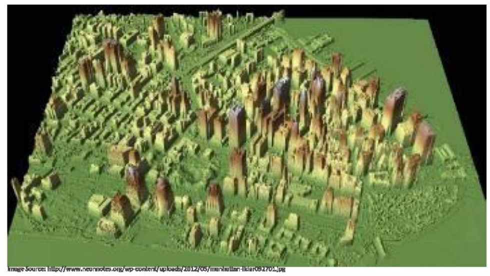
- How can we assess visibility in situations where the roadway infrastructure occludes a driver's view?
  - At intersections/around corners
  - Around horizontal curves
  - Over vertical curves

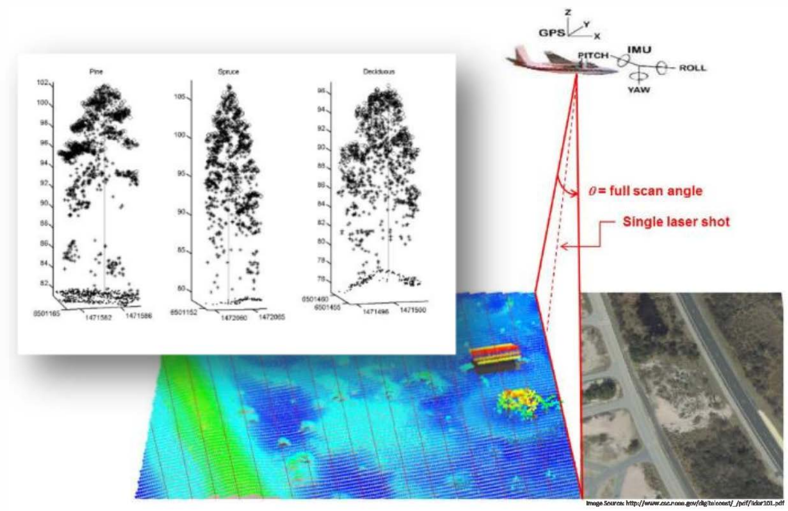
- Previous methods have included:
  - Video reduction
  - Road surveys



LiDAR – What?

- What is LiDAR?
  - Light Detection and Ranging
  - A remote sensing method used to examine the surface of the earth
- How is it collected?
  - Often by air
  - Uses a pulsed laser to measure ranges to the surface of the earth
  - Captures:
    - "Top" of vegetation, built-environment
    - Surface of the earth
    - Multiple pulses which penetrate through vegetation
  - Point-clouds





Challenges…

- Requires expert knowledge and specialized software
- Not available in all areas
- Can be difficult and costly to obtain
- Requires ability to handle extremely large datasets

LiDAR – How?

- How can we use it?
  - Create:
    - Digital Elevation Models (DEMs)
      - Bare-earth model
    - Digital Surface Models (DSMs)
      - Vegetation and built-environment
  - Collect:
    - Naturalistic or other driving data including GPS locations
  - Derive:
    - Driver eye-heights from vehicles used
    - Vehicle representations along path

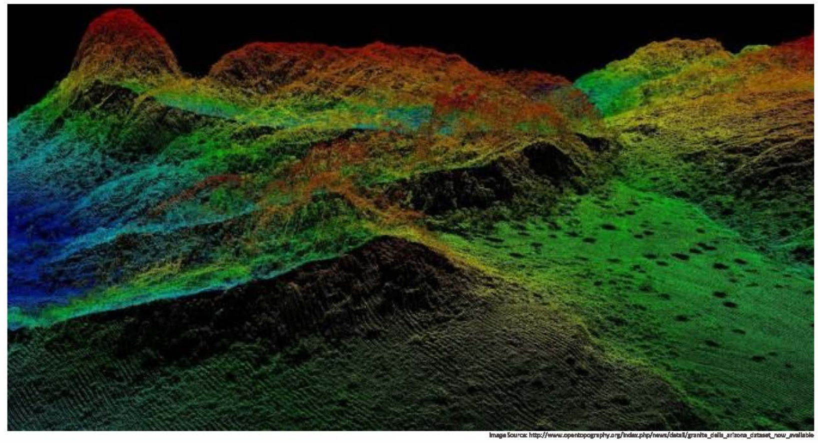
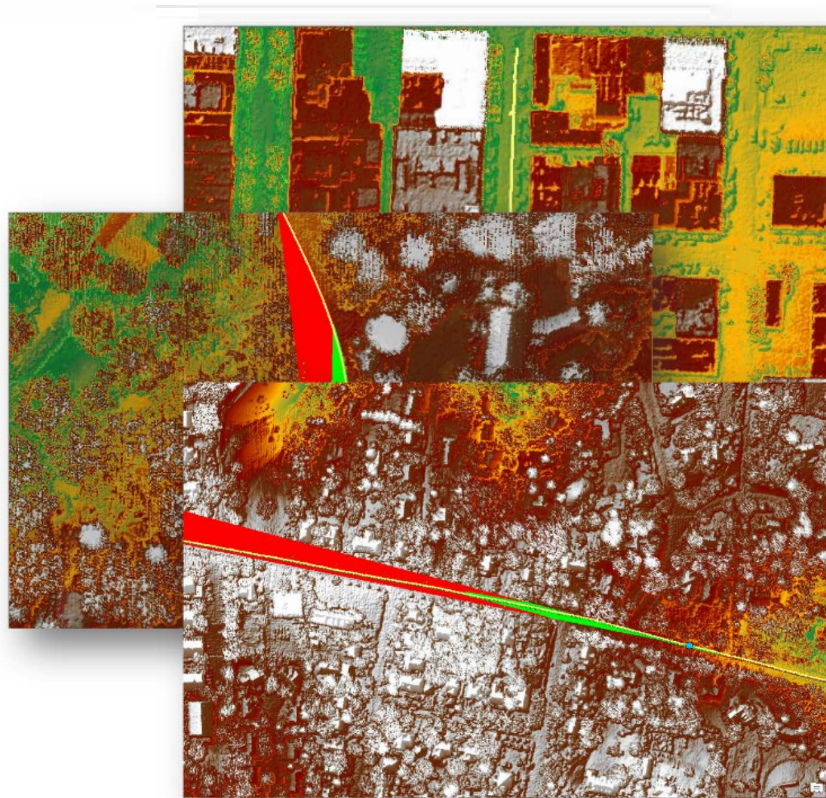


Image Source: http://www.opentopography.org/index.php/news/detail/granite_dells_arizona_dataset_now_available

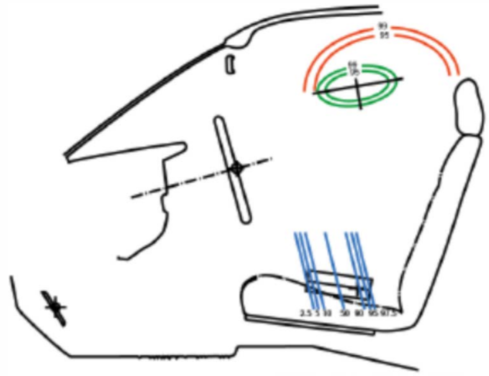
LiDAR – How?

- How can we use it?
  - Analyze:
    - Visibility at intersections
    - Visibility around horizontal curves
    - Visibility over vertical curves
    - …and more
  - Decide:
    - Use results from these analyses to make decisions about:
      - Roadway design
      - Vehicle design
      - How emerging technologies can overcome visibility issues
      - Etc.

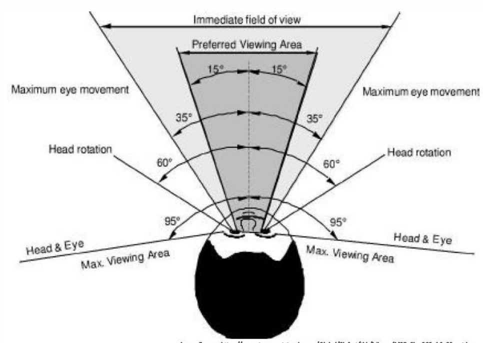


Measuring Visibility

- Driver eye height
  - Centroid of driver eye positions from ground (Sivak, et. al., 1996):
    - Cars: 1.11 meters
    - Light Trucks/Vans: 1.42 meters



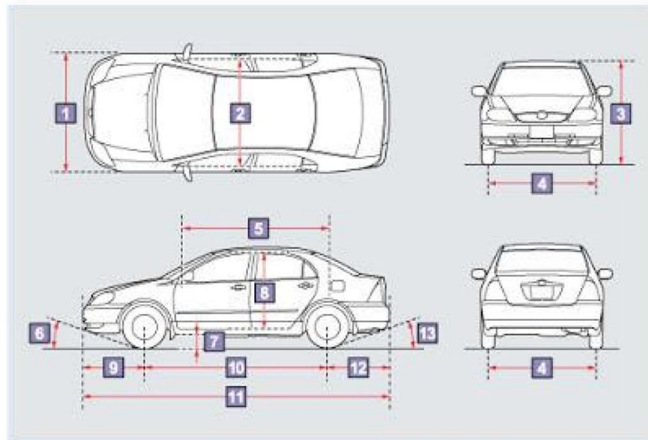
- Driver Field of Vision:
  - ~180° (Lockhart, et. al., 2009)



Measuring Visibility

Vehicle width

- Average widths (Edmunds.com, 2007):
  - Sedan Compact: 1.75 meters
  - Sedan Midsize: 1.81 meters
  - Sedan Large: 1.91 meters
  - SUV Compact: 1.80 meters
  - SUV Midsize: 1.87 meters
  - SUV Large: 1.99 meters

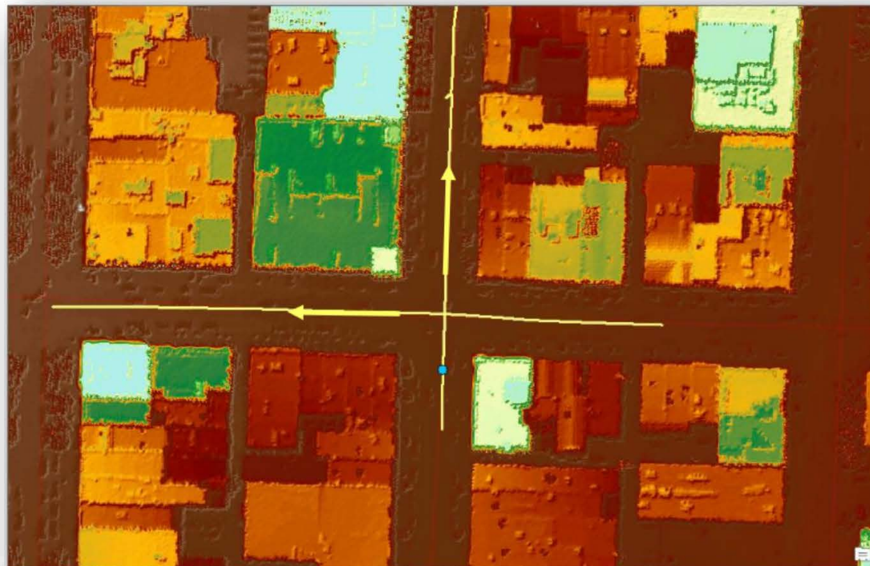


Vehicle height

- Average heights (Edmunds.com, 2007):
  - Sedan Compact: 1.46 meters
  - Sedan Midsize: 1.46 meters
  - Sedan Large: 1.49 meters
  - SUV Compact: 1.73 meters
  - SUV Midsize: 1.77 meters
  - SUV Large: 1.91 meters

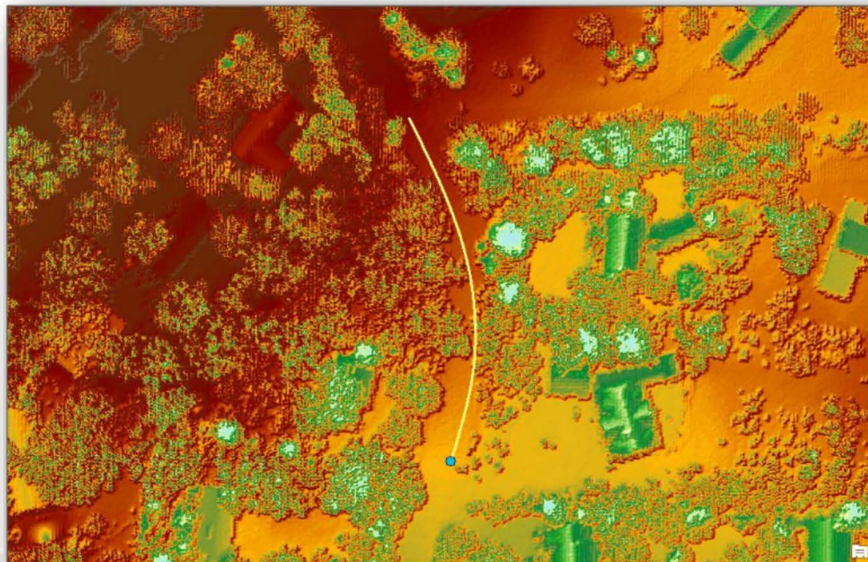
Urban Intersection Visibility

- Assess visibility from a stop bar of cross-traffic in an urban environment including multiple-story buildings and some vegetation.
- Methods for analysis:
  - Create vehicle paths
  - Model vehicle and driver eye-height
  - Model Topography



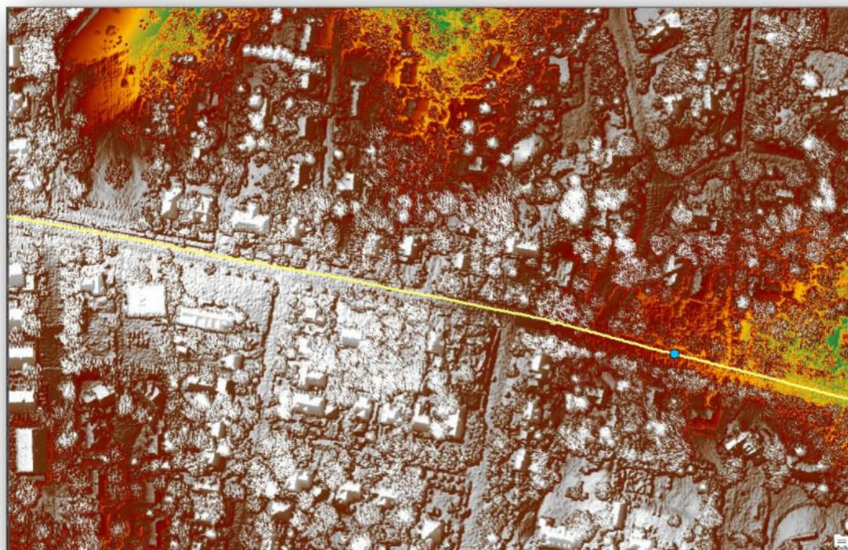
Horizontal Curve Visibility

- ➢Assess visibility within a curve in a rural environment including heavy vegetation and some buildings.
- ➢Methods for analysis:
  - Create vehicle paths
  - Model vehicle and driver eye-height
  - Model Topography



Vertical Curve Visibility

- Assess visibility within a curve in a rural environment including heavy vegetation and some buildings.
- Methods for analysis:
  - Create vehicle paths
  - Model vehicle and driver eye-height
  - Model Topography



Vertical Curve Visibility

- Analyze visibility
  - Visibility along sight lines
  - Identify first partial-car visible from driver's POV (orange)
  - Identify first full-car visible from driver's POV (blue)
  - Calculate distances

- Further Analysis:
  - Time to Collision (TTC)
    - Roadway is 25mph

Distance to	LOS
Last Visible Full-Car	166 meters
Last Visible Partial-Car	184 meters

TTC to	Along Path
Last Visible Full-Car	15 seconds
Last Visible Partial-Car	16.6 seconds

Conclusions

- LiDAR is a valuable tool for evaluating line of sight
- Though setup is time-intensive, able to be used as an automated process
- More objective and efficient than video reduction or survey methods
- Topic areas:
  - Roadway design
  - Vehicle design
  - How emerging technologies can overcome visibility issues
    - V2V
    - Autonomous
    - Etc.

Questions?

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