Exploring Remote Sensing Applications for Electric Utilities

Jason Parent, Chandi Witharana, Xinyi Shen
Remote sensing platforms

- Can be mounted on satellite, aircraft, motor vehicles, or tripods.

- LiDAR,
- Aerial imagery
- SAR,
- Sentinel
- Ground imagery
Sensors

Light Detection and Ranging (LiDAR)

Spectral Imagery

Synthetic Aperture Radar
LiDAR (aerial, low-resolution)

- Freely available in CT
- Useful for modeling:
  - terrain
  - forest canopy
  - land cover
Measuring forest canopy height

Forest Canopy Height Model
• Estimate of height at any given location
Identifying tree risk to infrastructure

- Use canopy height model to identify locations where trees are capable of striking power lines.
Evaluating tree risk due to environmental conditions

- Can environmental conditions help predict tree susceptibility?
- What conditions make trees susceptible to breakage or windthrow?
  - Poor wind adaptation
  - Shallow roots
  - Wind exposure
  - Trimming history
Validating a vegetation risk model

- Do trouble spot locations differ from locations with no trouble spots?
  - Compare statewide using airborne LiDAR and GIS data
LiDAR (aerial, moderate-resolution)

- Usefull for modeling:
  - Tree crowns
  - Small features (e.g. utility poles)

- Ground
- Low veg.
- Med. veg.
- High veg.
- Pole
- Wires
LiDAR (aerial, moderate-resolution)

Utility poles and wires

Tree tops and crowns

Products provided by vendor

- **Poles**
- **Wires**
- **Tree tops**
- **Tree crowns**
LiDAR (aerial, moderate-resolution)

Proximity of vegetation to wires

Distance from wires

- Veg. > 12’
- Veg. 8-12’
- Overhanging veg.
- Veg. 2-8’
- Veg. < 2’

Products provided by vendor
LiDAR (mobile, high resolution)

- Useful for providing data for engineering analyses.
- E.g. utility pole integrity mapping infrastructure obscured by tree cover.
LiDAR (mobile, high resolution)

Pole height

Pole lean > 10°

Products provided by vendor

- <32’
- 32-37’
- > 37’
Extracting information from LiDAR

- Large share of project costs, if done by vendor
- EEC goals include development of algorithms to automate in-house feature extraction.

LiDAR points
Reported lines
Mapped lines
Extracting information from LiDAR

- Point cloud analytics for automated extraction of pole attributes (height, lean, diameter)

<table>
<thead>
<tr>
<th>height (ft)</th>
<th>lean</th>
<th>Mean diameter (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>~ 39</td>
<td>&lt;10°</td>
<td>~ 12</td>
</tr>
</tbody>
</table>
Mapping with aerial imagery

- Aerial imagery is freely available for all of Connecticut.
- Explored feasibility of mapping utility poles and wires from aerial imagery.
  - 1400 student-hours invested
  - 100,000+ poles mapped
  - 42 towns completed
- Estimated time and cost for completing all towns:
  - 3500 student-hours
  - < $50K (at $12 / hour)
Google street-view (GSV) imagery

- GSV is freely available for the majority of roads in Connecticut.
- Outstanding dataset for classification of utility equipment that are difficult to identify in LiDAR point clouds (e.g. transformers, etc.)
- EEC is working on developing machine learning techniques to help automate identification of features seen in GSV.
Feature identification from GSV

- Complementary to accurate feature positioning provided by LiDAR point clouds.
Evaluation of GSV classification algorithm

- Cross-arm identification algorithm tested on > 900 poles.
- Detection accuracy ≈ 80%
- Locations triangulated from overlapping images; positional accuracy generally < 10 meters
  - Close enough to match to locations provided by LiDAR.
Flood Delineation by SAR data

- Hurricane Harvey event
Sentinel-1 Capability

Revisit frequency and coverage during Harvey (Aug. 27-Sept. 12)

Inundated “times”