Implementation of UAS Technology for Rock Slope Characterization

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Outline

• History – UAS in NHDOT
• Data Collection
  – Manual and UAS
• Data Analysis
• Results
• Conclusions
SPR2 funded DOT UAS assessment project & STIC grant based on the current EDC5 “Unmanned Aerial Systems”

SPR Purpose: Assess the use of UAS department wide – bridge, construction, design, etc.

- Geotechnical: compare a rock cut assessment using UAS data to that from data collected manually
  - PI: Prof. Jarlath O’Neill-Dunne, UVM SAL
  - Pilot: Tayler Engel, UVM
  - Instrument: DJI Phantom 4, data processed by UVM with Pix4D
  - Flight: July 26, 2017
• SPR2 provided the Dept. with guidance, experience, and factsheets
• STIC grant for ground based camera and software to create point clouds to analyze slopes using photogrammetry or structure for motion
Crawford Notch rock cut on Rt. 302
- Highest hazard in our rating system
- Over 100ft high and poor overall stability rating
- Limited shoulder/catchment width
- Remediation work was included in a drainage upgrade project
Traditional rock cut inspection/data collection techniques: manual methods
- Brunton compass, field book…
- Rope access methods or from the ground
- Without rope access method measurements and inspections are limited
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- Road hazards – sight distance
- Block size and stability, dimensions, and changes
- Recent rockfall data
- Structural data
- Pictures for documentation
Coordination with maintenance: Work on a catch basin the same day necessitated the closure of a passing lane and allowed for room to fly UAS.
• UVM acquired 1.5 ha area and processed the data, resulting in:
  – Oriented point cloud (1.94x10^7 points, 167/m^3 0.66 cm GSD)
  – 310 high-resolution images (and 2 videos)
Photo panorama (top) and point cloud (bottom)
Original image (left) and point cloud (right)
Original image (left) and point cloud (right)
• DOT used Split-FX and RocScience’s Dips for fracture analysis
• Orient point cloud in Split-FX
• Create mesh
• Find patches (auto)
• Inspect and edit patches
• Add traces
• Stereonet analysis

Top: Point cloud
Bottom: Auto-identified fracture surfaces (multi-colored) and manual fracture traces (pink)
Viewpoint: Looking up at the rock face as if standing on the road
• Analysis shows failure by wedge sliding, plane sliding, toppling

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<tr>
<th>Kinematic Analysis</th>
<th>Wedge Sliding</th>
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<tr>
<td>Slope Dip</td>
<td>85</td>
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<tr>
<td>Slope Dip Direction</td>
<td>236</td>
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<td>Friction Angle</td>
<td>30°</td>
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<tr>
<th></th>
<th>Critical</th>
<th>Total</th>
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<tbody>
<tr>
<td>Wedge Sliding</td>
<td>96302</td>
<td>188128</td>
<td>51.19%</td>
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- Orienting cloud: variable instrument direction
- Mesh smooths surface
- Sampling bias parallel instrument
• Drone allows measurement of *many* more structural measurements than possible by hand
• Increased coverage, time to assess by bringing into the office
• Ability to measure, heights, volumes, profiles of otherwise unreachable spots
• Quantify change and ongoing slope monitoring
• Detailed profiles – project level data
• Data can include sample bias and there is additional processing time
Questions?