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Structure from motion on Salish shores: remote mapping for restoration

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Structure from Motion on Salish Shores: Remote Mapping for Restoration

Branden Rishel
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Beaches in the Region: Why Care?

- No coral, not much sediment from rivers
- Feeder bluffs supply ~90% Salish Sea beach seds
- Natural gravel required for forage fish spawning
  - Surf smelt, sand lance, herring
  - Messed up by bulkheads, seawalls, etc.
- Forage fish a keystone species; food for salmon
  - Also food for seabirds and marine mammals

Natural beaches are critical to Puget Sound biodiversity.
Path to Acceptance of SfM

- Limited R&D in a seven-person company
- Kites, camera-on-a-stick, ground photos
- Initial efforts quick and dirty
- Long path to billable UAV work
Opportunistic SfM (during other field work)
SfM with Others’ Aerial Photos
Ground Photo SfM

- Not even a stick
- One-point ground control with laser rangefinder/inclinometer offsets
- Still useful!
Why Structure from Motion? When?

Structure from motion is a cutting-edge 3D imaging tool that other folks are successfully using to study geomorphology. It’s accessible, quick, and gives results that fill a gap between other techniques. It won’t replace any other technique, just like a handheld Trimble GPS doesn’t replace a total station.

<table>
<thead>
<tr>
<th></th>
<th>Total Station Survey</th>
<th>Structure from Motion</th>
<th>LiDAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>Very low</td>
<td>Highest</td>
<td>High</td>
</tr>
<tr>
<td>Precision</td>
<td>Very high</td>
<td>Varies a lot</td>
<td>High</td>
</tr>
<tr>
<td>Color texture map</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>CGS can do</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Staff time</td>
<td>High (2 simultaneous)</td>
<td>Moderate</td>
<td>N/A</td>
</tr>
<tr>
<td>Works underwater</td>
<td>Yes, to ~4 feet</td>
<td>No</td>
<td>Not really</td>
</tr>
</tbody>
</table>

Photos can be taken quickly, during currently scheduled site visits. A small site might take 20–30 minutes. A decision can be made later about whether to build a SfM model—the time-consuming part.
SfM Compared to Total Station

- Demonstrated better resolution
- Caught a missed inflection

Figure 1. Topography (top) and orthomosaic (bottom) of Boulevard Park drift sill reconstructed from 368 aerial photos using structure from motion. Boulevard Park, Bellingham.
Armor Encroachment on Tribal Lands

- Larger budget for visualizations
SfM to CAD + 3Ds

- Very good vertical essential
- GCP from licensed surveyors
Armor Encroachment on Tribal Tidelands
Reference Beach
Drone!
Fun mapping for future change

- Future park on fill
- Planned beach restoration
- Future sailing facility?
Eelgrass Mapping

- Good enough for pre-design
Sonar + UAV Surface

- Dredging to nourish
  - Not going to work
- Sonar with water level plus UAV SfM
  - Surface match within ~1-3”
- CAD wizard Adam is busy
Orthomosaics Most Useful?
Lummi Shore Road

- 5.5 miles long, stitched
- 7 field days
- PPK GPS ground control
- Lower target resolution
- During BC fires!
Homeowner Scale

- Precise quantities
- Nice views
- Techy!
Kite Photos where UAVs Not Permitted

- Cheap
- Tricky
- Requires >10 knots surface wind
- Attitude control not important
Upcoming Work

- Wavelet analysis of surface grain size
- Sediment budgets
- Possible bathymetry
- Immersive visualizations in Unity
- Alpine forest mapping (me but not CGS)
- Automated armor extraction?
Questions?