Abstract

Digital Mapping comparison utilizing UAS

W. Lau (Portland State University, wlau@pdx.edu)

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Given the recent availability of small unmanned aircraft systems and computing power, the ability to perform structure from motion analysis at low cost has created new opportunities for digital mapping. This study examines several survey sites utilizing various structure from motion software packages, along with a comparison with existing LIDAR data, to assess the technique's suitability for site mapping and rapid data generation. The study sites involve an urban site and a vegetation dominant state park adjacent to the Willamette River. The results show that SfM packages can, within the confines of the computing power available, match up with existing LIDAR imagery to provide rapid mapping services to the geographer. Packages compared in this analysis are Agisoft Metashape Pro, Pix4D mapper, and the open source OpenDroneMap project. LIDAR source is the 2014 Oregon Lidar Consortium Portland Metro survey.

Digital Mapping comparison utilizing UAS

Wayne Lau
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Methodology Comparison of UAS Mapping

Multiple comparisons

- UAS photogrammetry vs LIDAR
- Differing sites - River environment vs Urban boundary
- Differing software - Metashape, Pix4d, and WebODM (OpenDroneMap)

Constants and Experimental Configuration

- Same imagery across software packages
  - 12 megapixel DJI Mavic Pro Camera
  - 350 feet AGL
  - ‘Hammer’ IOS flight control software, double mapping.

Constants and Experimental Configuration

- Ground Control Points
  - Altitude and GPS location via Cell phone GPS/Altimiter, calibrated to known survey points.
  - Permanent visual marker on ground or placed marker utilized as GCP.
- Computing System
  - Core i7, 7700k with 32gb of RAM and a 2TB Flash. Geforce 1080ti GPU.

Comparison of Sites

Site 1 - Salem Neighborhood, 300m x 300m, 172 images, 872mb, processing time, 1 hour

Site 2 - Molalla River, 626 images, 3.2gb, 500m x 1000m, processing time, 4 hours

Site 3 - Salem School, 1216 images, 6.8gb, 1km x 1km processing time, 2+ days (errored out)

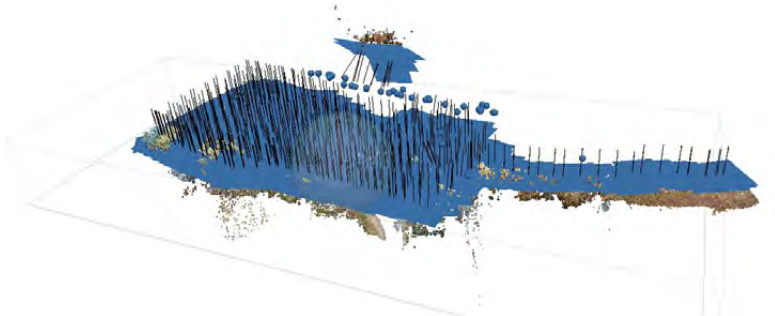
Salem Neighborhood

- 300x300m
- Significant errors around site edge
    - Corrected with con tool (removed values out of range)
- Manual check of shadowed areas did not encounter excessive errors.

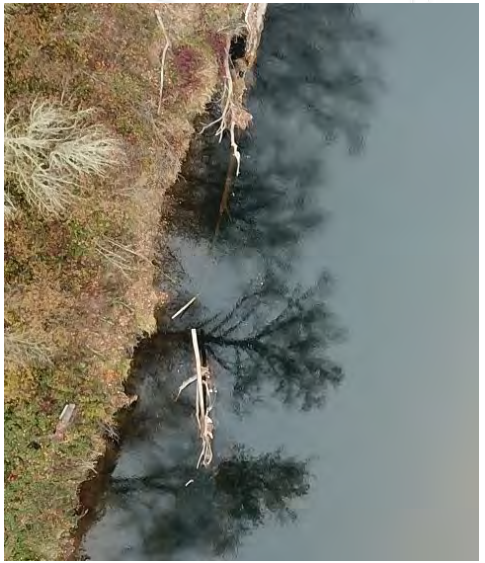
Site 1: Salem Neighborhood

- Generated DEM aligned with existing LIDAR and elevation data
- Estimated heights are accurate.
    - Street Elevation is 681', Roof elevation nearby is 704'.

Molalla River

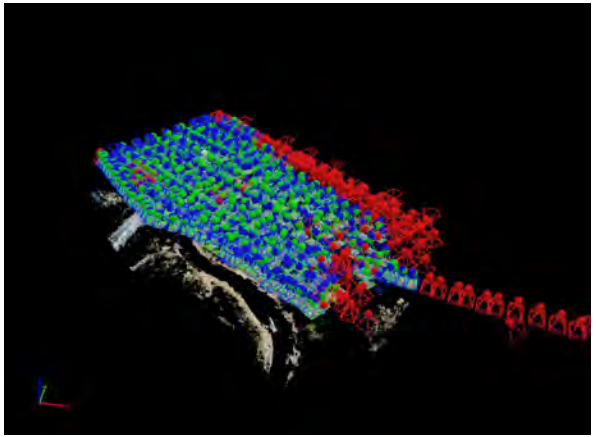


- 500m x 1000m
- River site proved challenging
- Calm, still waters and a wide river meant that there was large amounts of reflection and entire photo frames which consisted of only water, thwarting automated tie point alignment.



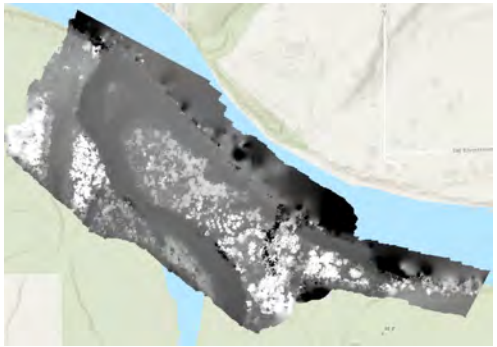
Molalla River - Pix4D

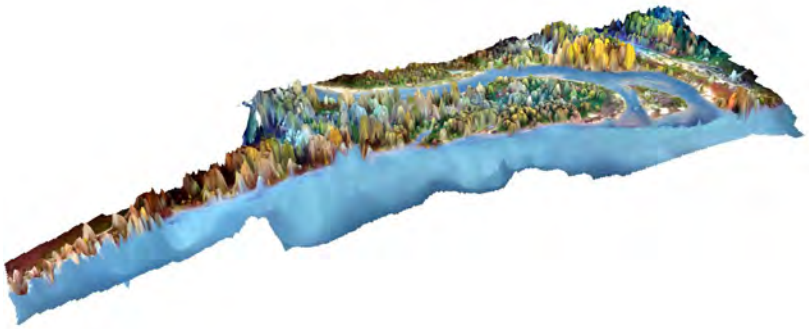
- Failed tie point generation
- Significant errors in DSM generated
- Generated results without significant manual intervention, results were poor.

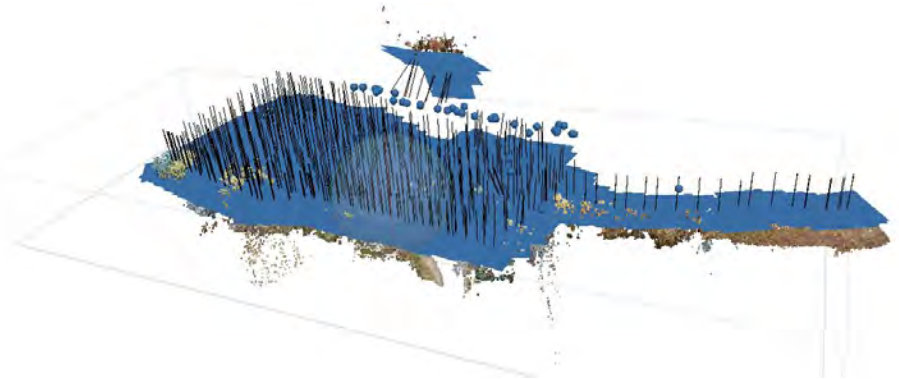


Molalla River - Metashape

- Significant manual intervention required to remove misaligned pictures.
- Generated Ortho meets ‘eye test’
- Generated DSM had errors.
- DSM was very high resolution

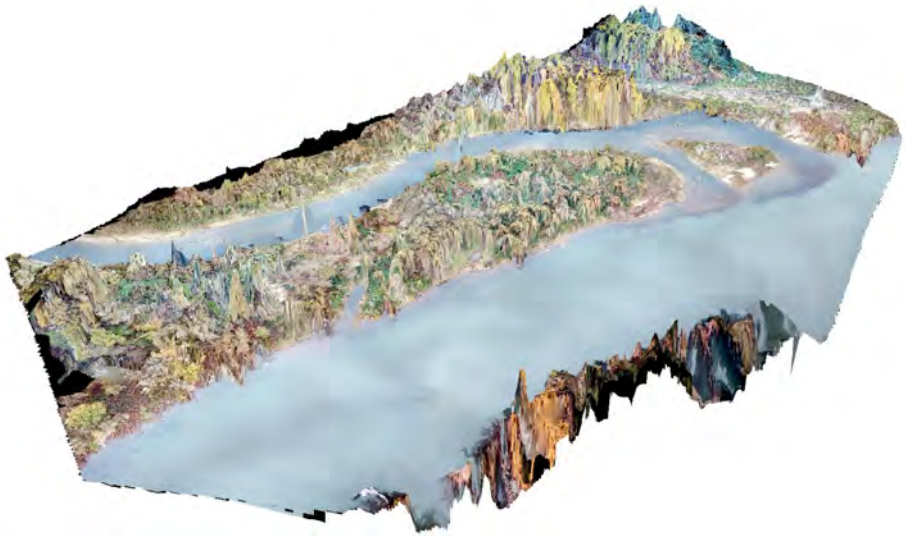






Molalla River - WebODM

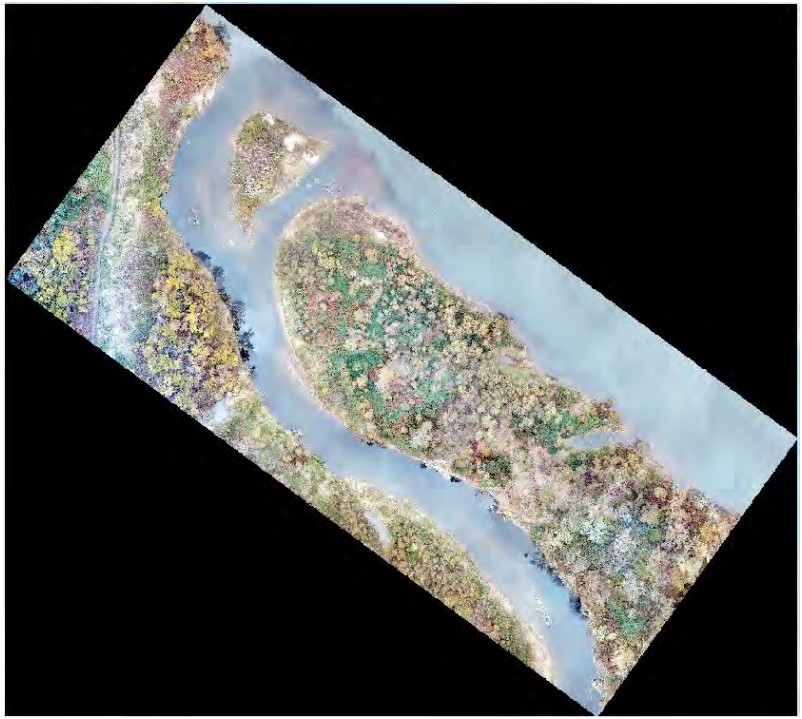
- Generated Ortho / DSM with little manual intervention.
- DSM had errors along low data areas around edges, otherwise handled water and shadows in a fairly error free method by eye test.
- DSM was relatively low resolution

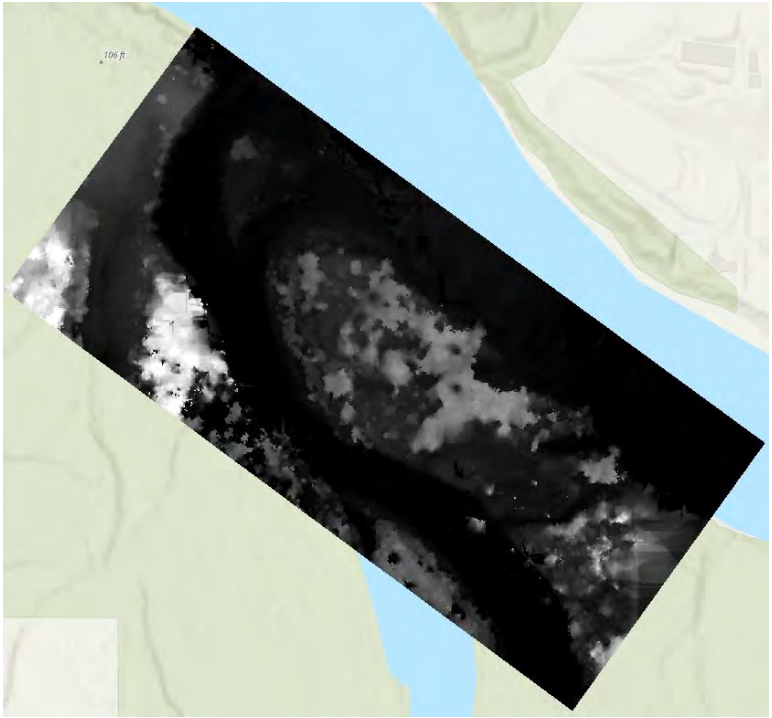


Molalla River - DSM and Orthos

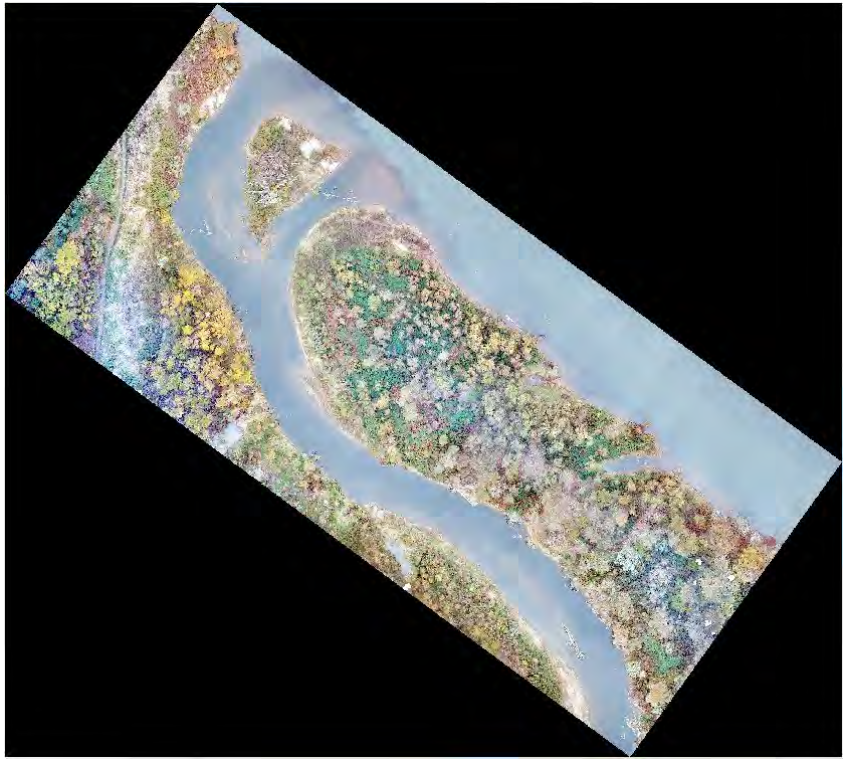
- Imported the WebODM and Metashape products into ArcGIS Pro for a side by side comparison.
    - Clipped all input rasters to equivalent size/shapes and remove the edges with poor data overlap.
    - Utilized con tool to remove bad data points due to shadows and uneven water heights.
    - Utilized raster calculator to correct baseline elevations to known river surface elevation.

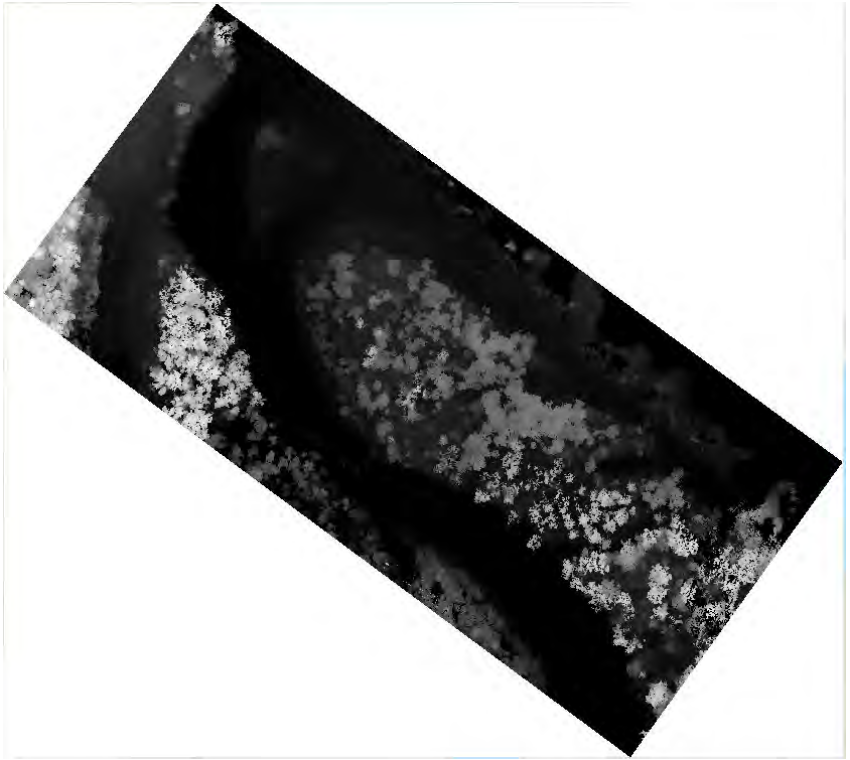
WebODM





Metashape





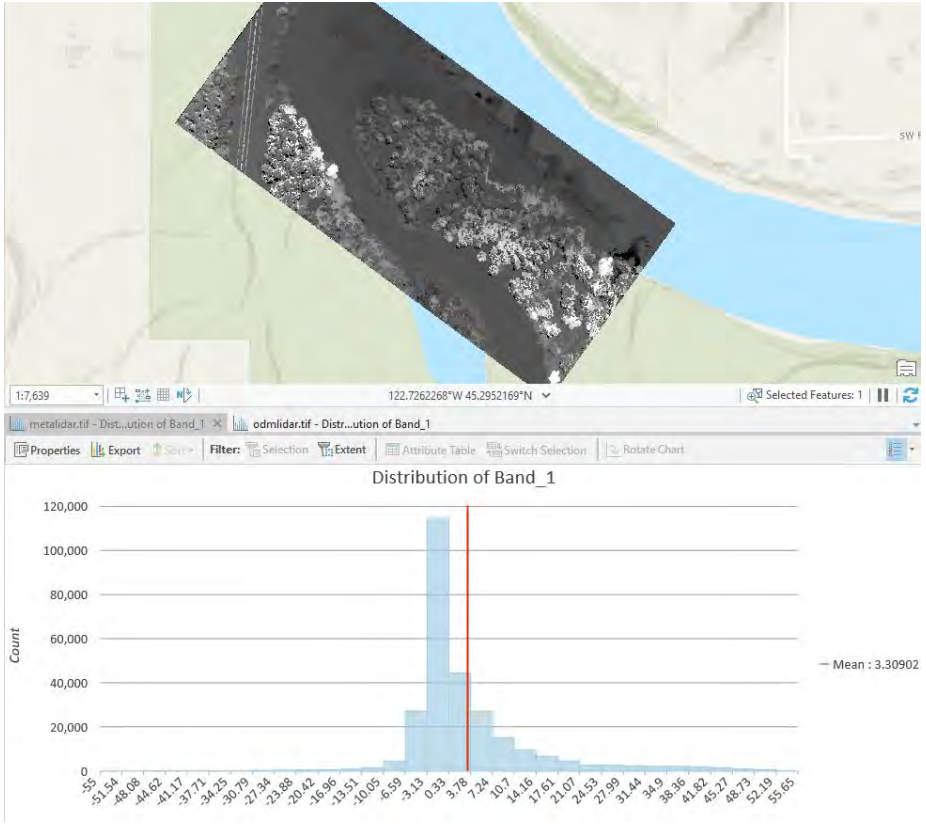
Generated 3d

WebODM

Metashape

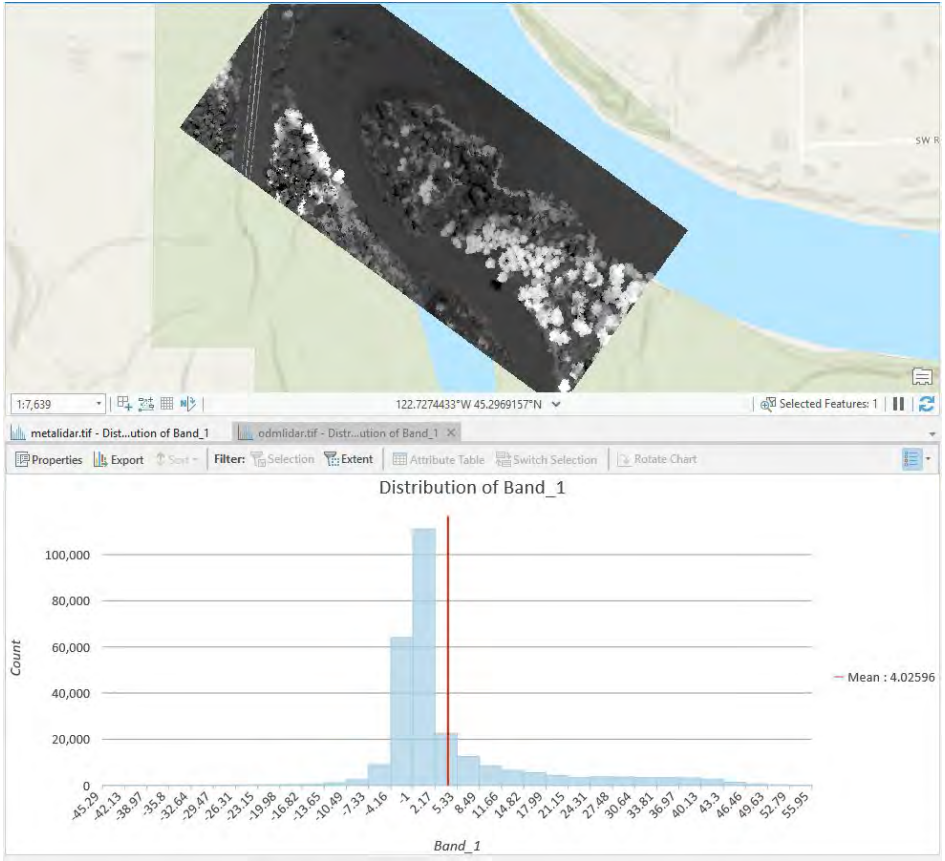
Metashape Lidar Comparison w/ 2014 OLC

- Raster calculator subtraction of the metashape DSM from the Highest Hit LIDAR from 2014 OLC Metro
- Visually - biggest differences are in some of the tree heights, possibly from 5 years of tree growth.
- Calculated mean - 3.3m, with the histogram mostly at 0.



WebODM Lidar Comparison w/ 2014 OLC

- Raster calculator subtraction of the WebODM DSM from the Highest Hit LIDAR from 2014 OLC Metro
- Visually - biggest difference are in some of the tree heights, possibly from 5 years of tree growth.
- Calculated mean - 4m, with the histogram mostly at 0.



Conclusions

- UAS based structure from motion mapping can produce comparable results with LIDAR. Given the 5 years that have passed since the last LIDAR survey, the data shows tree growth over that time period while shore conditions have remained constant.
- SfM software has issues with water / reflections, with some having more difficulties than others.
- SfM processing time scales with number of input images until hitting a RAM/resource limit.