

AS226975

Using Reality Capture to Help with Hurricane Harvey Relief Efforts

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Learning Objectives

- Discover what photogrammetry is, its application, and its limitations compared to other reality-capture methods
- Discover best practices for capturing data using a combination of UAVs, GoPros, and terrestrial devices
- Compare and contrast various photogrammetry software to find out which is best for certain applications
- Learn how to interpret the results of the photo mosaic, 3D mesh, and point clouds, and use them in applications such as ReCap, Navisworks, Revit, and 3ds Max

Description

Hurricane Harvey was a Category 4 storm that hit Texas on August 25, 2017. It caused \$125 billion in damage, more than any other natural disaster in US history except Hurricane Katrina. It affected 13 million people from Texas through Louisiana, Mississippi, Tennessee, and Kentucky. Harvey made landfall 3 times in 6 days. At its peak on September 1, 2017, one-third of Houston was underwater. In the first 24 hours, 2 feet of rain fell. Flooding forced 39,000 people out of their homes and into shelters. We got a chance to visit a friend and colleague who lost 3 cars, their entire first floor, and their folks' home around the corner. By using photogrammetry, reality capture, drone footage, Revit software, and ReCap software, we were able to help record conditions for this devastating event.

Speaker(s)

Dat Lien (speaker)

After traveling all over the globe for renowned architectural firms such as Gensler, PGAL, and Morris Architects; and after managing a team of experts at Total CAD Systems, an Autodesk reseller, Dat Lien now adds entrepreneurship to his repertoire with the formation of Axoscape, a BIM consulting and Building Information Modeling company dedicated to helping the AEC industry with BIM adoption. With over a decade of architectural experience, Dat combines leveraged technology with the AEC business so clients can stay competitive while maintaining flexibility. When he's not helping AEC firms with BIM services, he's busy with organisations such as the Houston Area Revit Users Group / BIM Peer Group, AGC, ABC, the AIA, A Child's Hope and his alma matter, Texas A&M University. Utilising his education, experience, and eagerness to help, Dat enjoys sharing ideas with others everywhere he goes.

Xavier Loayza (co-speaker)

Xavier is a civil engineer interested in applying proven technologies to help the AEC industry. His experience covers mapping and photogrammetry projects, transportation and geotechnical engineering for roadways, and BIM consulting. His passion for technology began from shaping wings on foam and eventually led up to establishing a company in Ecuador to primarily fly UAVs for cadastral projects. In 2015, Xavier joined a Construction Management graduate program at University of Houston. Currently, he is collaborating with Axoscape, a BIM consulting company where they work to make the AEC industry a better place. Xavier is always eager to learn and share.

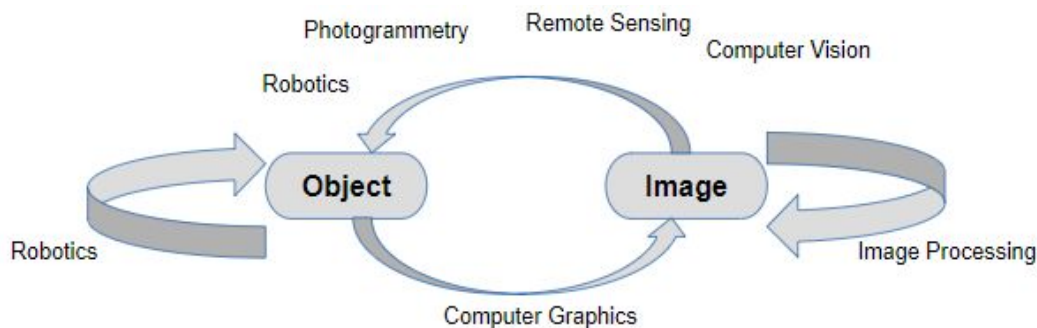
Introduction

Photogrammetrists and cartographers collaborate to bring together geographic information by collecting and interpreting measurements of the earth surface. Lidar, sonar, or photographic sensors were mounted on aircrafts to cover large extensions of territory. These project types used to have a high cost due to the equipment required. However, the technological advances have reduced the cost of quality hardware and software for mapping. This makes mapping projects more feasible for small-medium size areas. The applications are almost endless in the AEC industry and others.

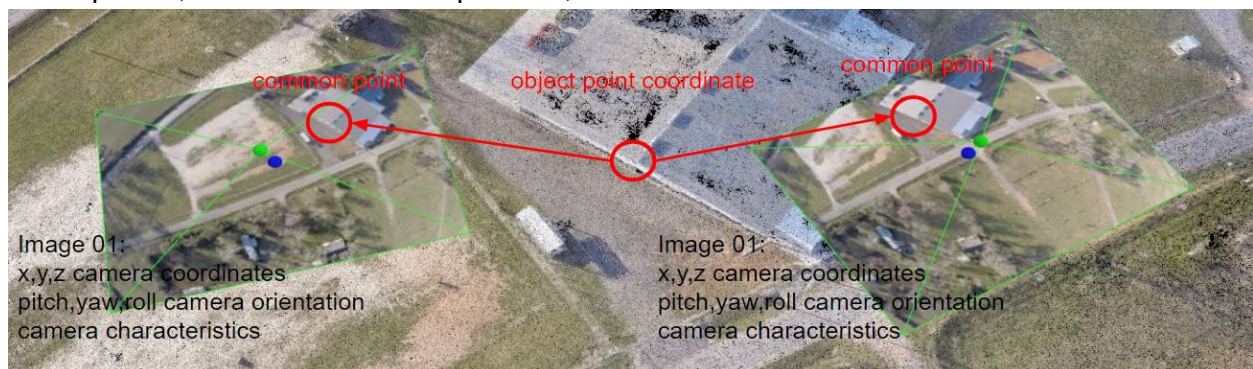
The intention of this informative session is to show how to incorporate photogrammetry outputs into our BIM/visualization projects by capturing and processing data according your needs. We will also help you to figure out the software that most fit to your project types.

What is Photogrammetry?

Photogrammetry is the estimation of physical objects geometry based on image representations of those objects. This allows to make measurements of real world objects from photographs. The recognition and triangulation of common features from two or more images allows the estimation of location and orientation of the sensor that capture the image creating lines of sight.



By using projective geometry and optics (intrinsic camera parameters), it is possible to calculate the location of these common features in our coordinate system. However, if the images do not have longitude and latitude coordinates, photogrammetry outputs will not have scale. In consequence, 3d reconstruction is possible, but absolute measurements are not.



Applications

- Mapping and surveying
- City planning
- Facade reconstruction
- 3d reconstruction
- Gamification
- Construction planning and safety
- Historical comparisons
- Project monitoring
- Crowdsourced cultural heritage preservation

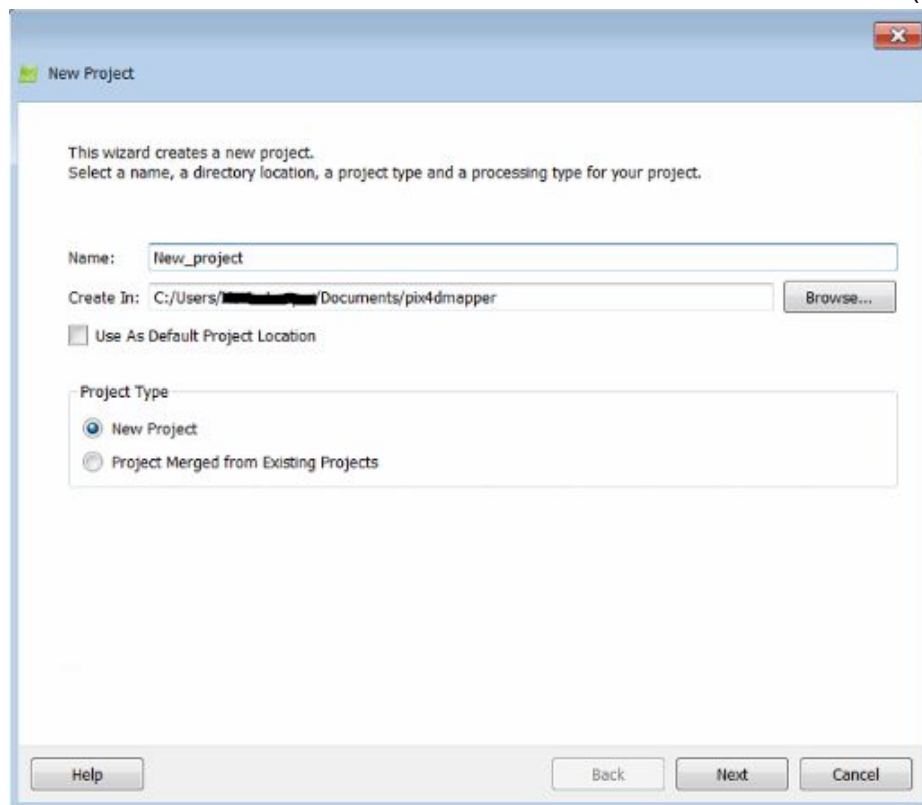
Photogrammetry Software

There are variety of commercial software available to process images into 3d geometry. The ones we are going to cover are Pix4D, and Recap 360.

Pix4D workflow

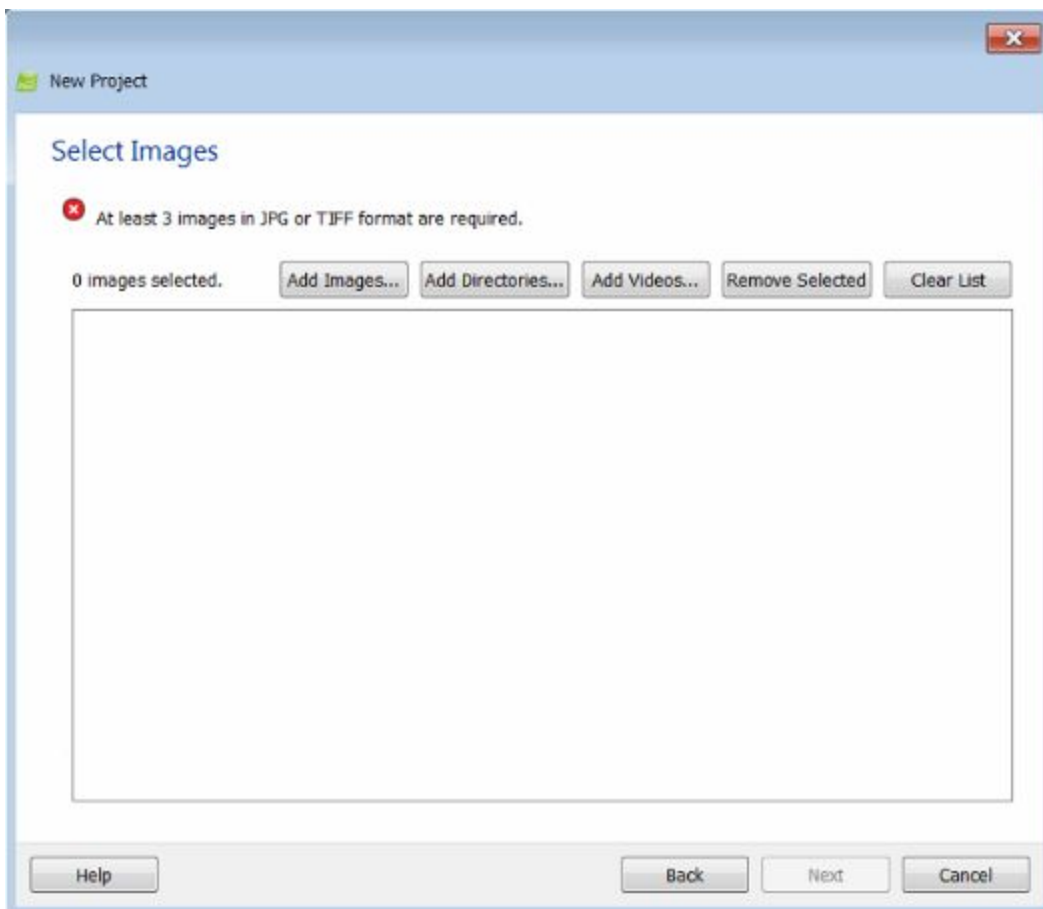
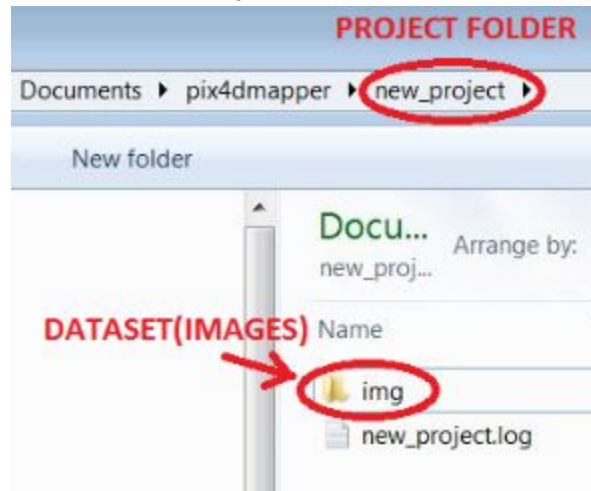
1. Open Pix4Dmapper, and create a new project. Click “Next”. By default Pix4D projects are stored in user/Documents/pix4dmapper/

Note: From my set of projects, I can tell that my average project size is 4.7GB. This program uses a lot of CPU and GPU resources and also runs better on a Solid State Drive (SSD).

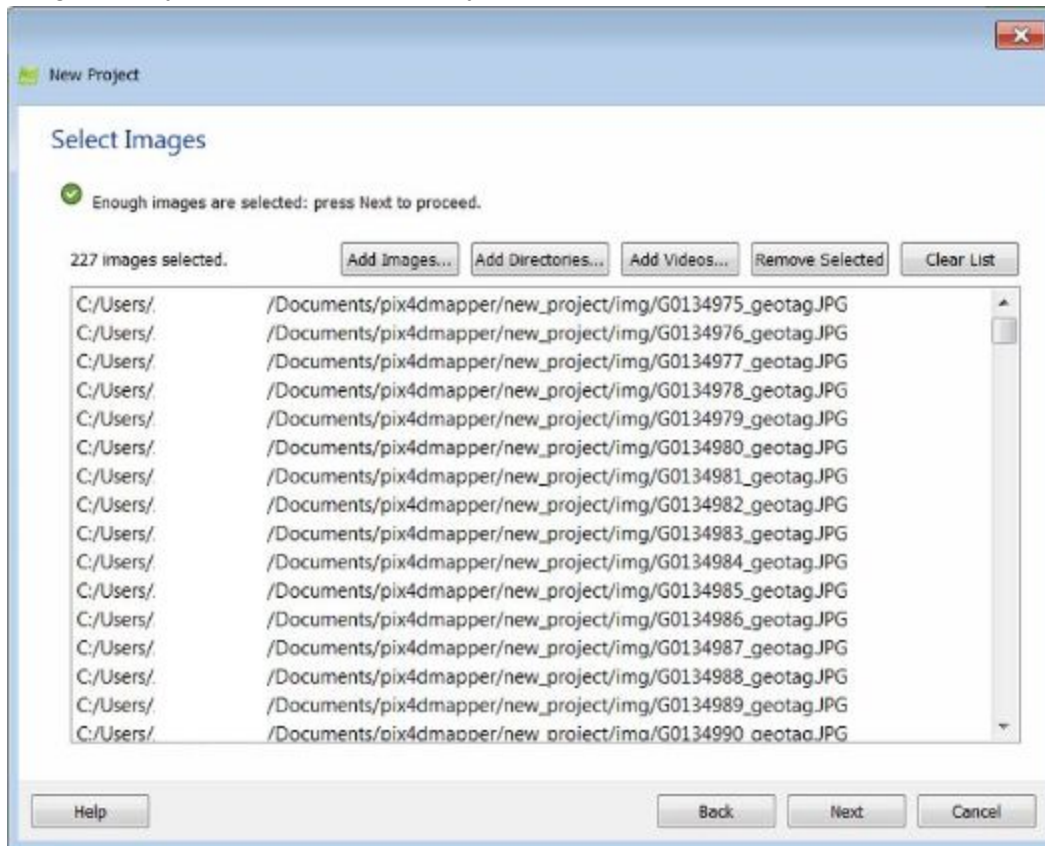


2. Select your input files (Images or videos).

Note: it is recommended to save the image folder inside the project folder. This data structure helps to keep source files connected to project path.



When videos are added, frames are extracted based on frequency. (i.e. 1 image every 90 frames). In general, video frame rates are in the range of 25-30 frames per second. Double check that the frames were extracted in the right directory. If everything is ready, click on “add directory” and click “next”.



3. In the image properties window, check the coordinate system and accuracy. Most of the time the default values are good enough.

Note: Remember, if there are not coordinates of the approximate location of the camera when each image was captured, the 3d model generated from the images will have NO SCALE. Click next.

Check on the group column that all the images belong to “group1”. Sometimes, when the source of data comes from different cameras, images get grouped. This may cause wrong outputs.

Omega, Phi, and Kappa columns refer to the camera orientation when the image was captured. In the absence of these values, the program estimates the rotation of each image based on triangulations and projections.

NO COORDINATES => NO SCALE

Enabled	Image	Group	Latitude [degree]	Longitude [degree]	Altitude [m]	Accuracy Horz [m]	Accuracy Vert [m]	Omega [degree]	Phi [degree]
<input checked="" type="checkbox"/>	G0134975_g...	group1	30.0752222	-96.0372500	153.320	5.000	10.000		
<input checked="" type="checkbox"/>	G0134976_g...	group1	30.0751111	-96.0369444	152.870	5.000	10.000		
<input checked="" type="checkbox"/>	G0134977_g...	group1	30.0750278	-96.0366111	152.930	5.000	10.000		
<input checked="" type="checkbox"/>	G0134978_g...	group1	30.0749444	-96.0363056	153.740	5.000	10.000		
<input checked="" type="checkbox"/>	G0134979_g...	group1	30.0748333	-96.0360000	153.000	5.000	10.000		
<input checked="" type="checkbox"/>	G0134980_g...	group1	30.0747500	-96.0356667	153.190	5.000	10.000		
<input checked="" type="checkbox"/>	G0134981_g...	group1	30.0746667	-96.0353611	153.300	5.000	10.000		
<input checked="" type="checkbox"/>	G0134982_g...	group1	30.0745556	-96.0350556	153.840	5.000	10.000		
<input checked="" type="checkbox"/>	G0134983_g...	group1	30.0744722	-96.0347500	153.430	5.000	10.000		
<input checked="" type="checkbox"/>	G0134984_g...	group1	30.0743889	-96.0344444	153.820	5.000	10.000		

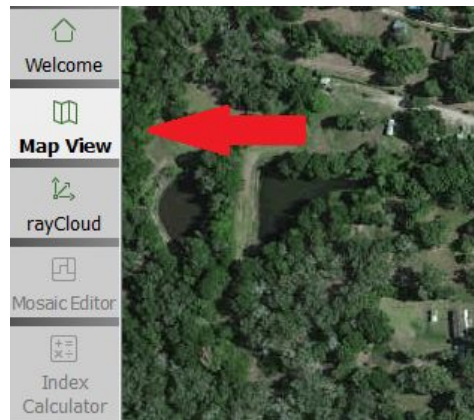
- In the processing options template window, select the option that best fits your project type

Template	Applications
3D Maps	Surveying, Orthomosaic (google maps type), digital terrain models, GIS applications, urban reconstruction
3D Models	3D building, 3D object, and interior reconstruction, urban reconstruction, landscaping, architectural design support, clash detection
Agriculture	Vegetation index map, vegetation coverage.

There is also a low resolution version for each of the three templates. This speeds up the processing time lowering the quality/resolution.

- The last step on setting up the project is to select the output coordinate system. Coordinate with the team responsible on this matter to match units and coordinate systems. Photogrammetry software tends to use metric system as default. Click on Finish. However, when importing photogrammetry output into Revit, the units can be previously corrected in Recap or just Revit (It depends on the input file). Revit does not have a coordinate system tool so, as long as the true north is right there is no problem.

- The first display presented by Pix4D when the images were geotagged (image + coordinate) is the Map View.



If the images were not geotagged, Map View is not going to show camera locations like the following figure.



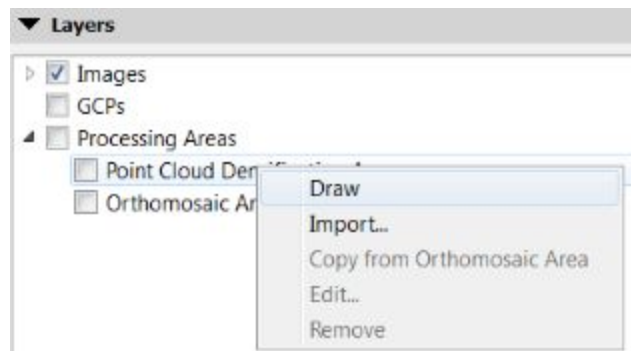
The Map View allows to set the boundary of the area covered by drawing a polygon or importing a polygon. Under the “Layers” tool pallet > Processing Area > Point cloud densification, right click and select Draw (most of the time) or Import if that is your case. This procedure prevents you to have undesirable or erroneous extrapolation of data out of the boundaries of your mission plan.

Without processing area on Mesh



With processing area on Mesh



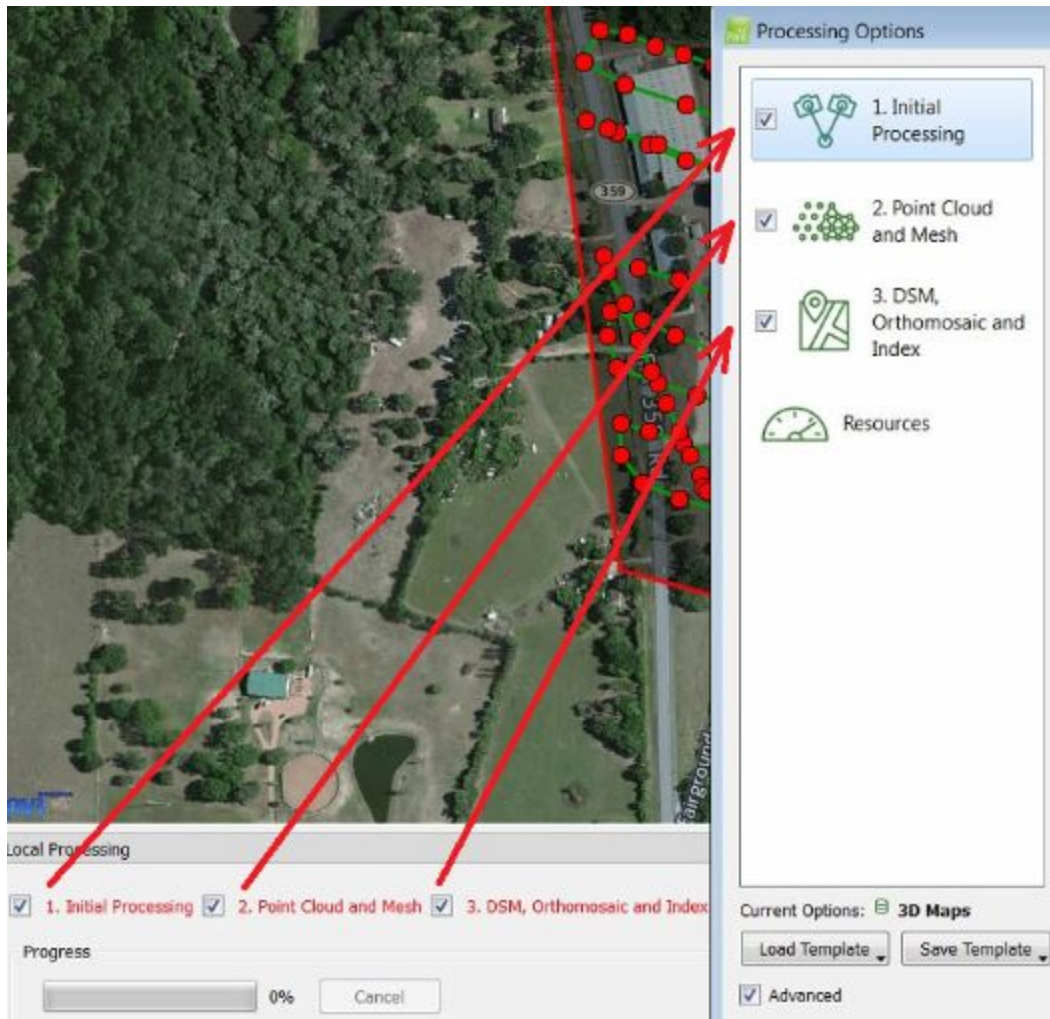


Finish to draw by clicking the right button of your mouse. Apply the same boundary to the Orthomosaic Area by “Copying from point cloud densification area”. On more recent version of Pix4D, the boundary gets applied automatically to both processing areas.

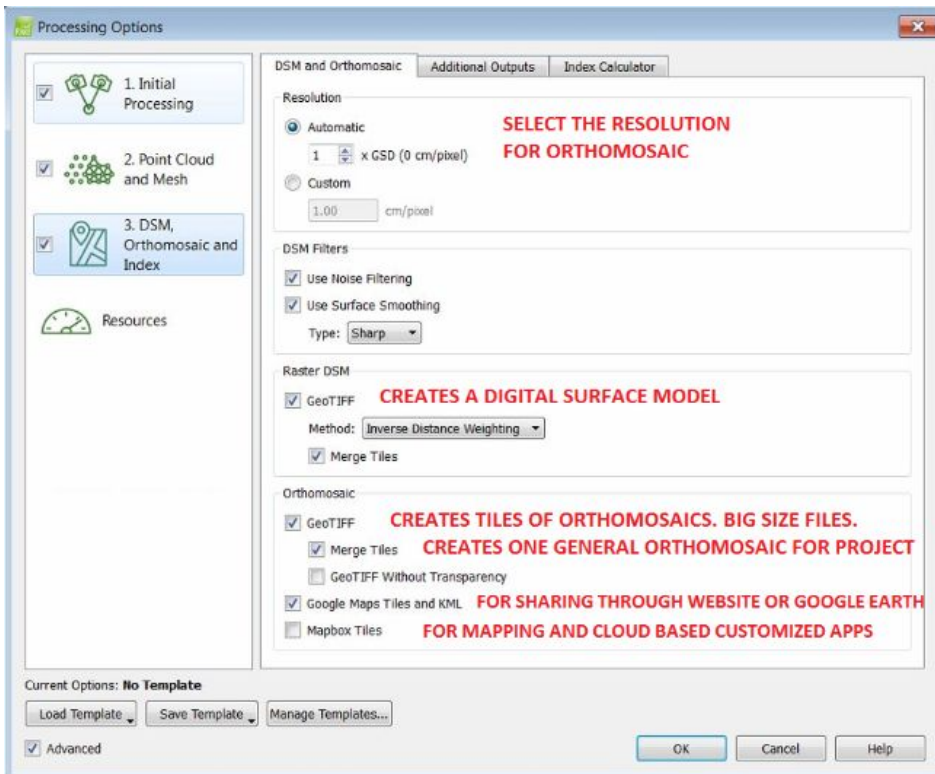
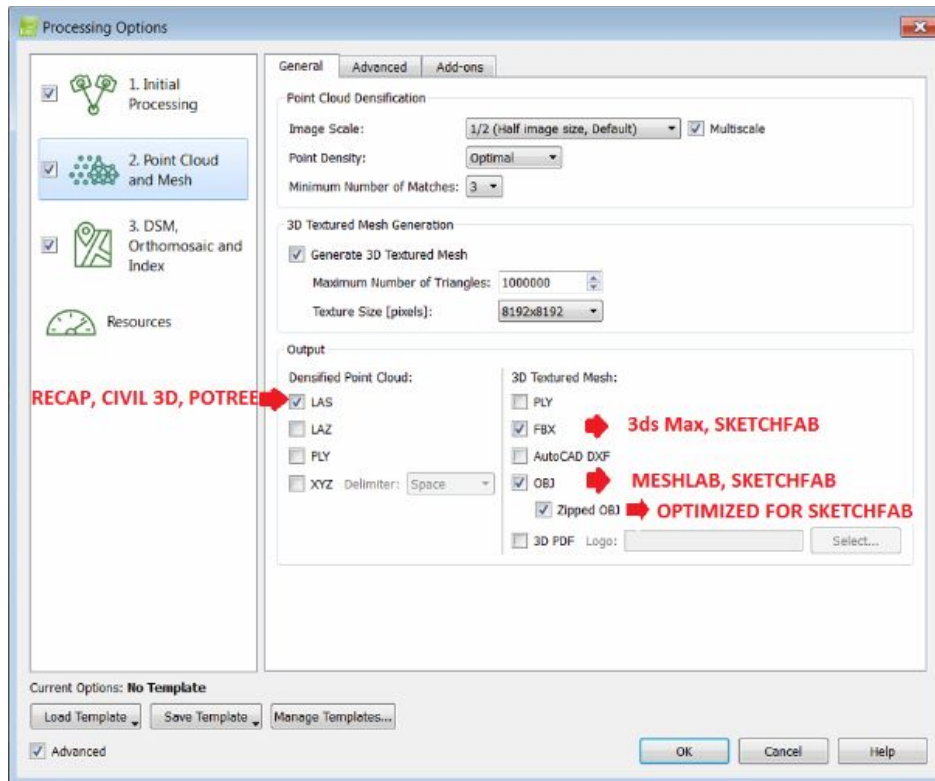
7. Now, we are almost ready to start the processing stage.



There are 3 steps that the software follows. Before starting the process, it is recommended to click “Options...” to select up the desired outputs. The default options found in this window correspond to the Template selected in the Step 4 of this workflow.



In the processing option window, there is one tab for each local processing step where we can configure outputs and processes.



Click “OK” when the configuration process is done. Then, on the Local Processing bar, at the bottom, it is recommended to uncheck “2. Point Cloud and Mesh” and “3. DSM, Orthomosaic and Index”. By doing so, it is possible to review on the preview output and quality report if the results seem correct. At this point, this is important because the “2. Point Cloud and Mesh” and the “3. DSM, Orthomosaic and Index” step take a lot longer time to process. Going step by step, the user keep more control of the result avoiding having to go back to run all the processes again.

8. Once the “1. Initial Processing” is done, camera location and orientation, image matching, and calibration of the model are completed during this step. A quality report presents preliminary status of the project.

9. If the results come as expected, check “2. Point Cloud and Mesh” and “3. DSM, Orthomosaic and Index” boxes and run it again.

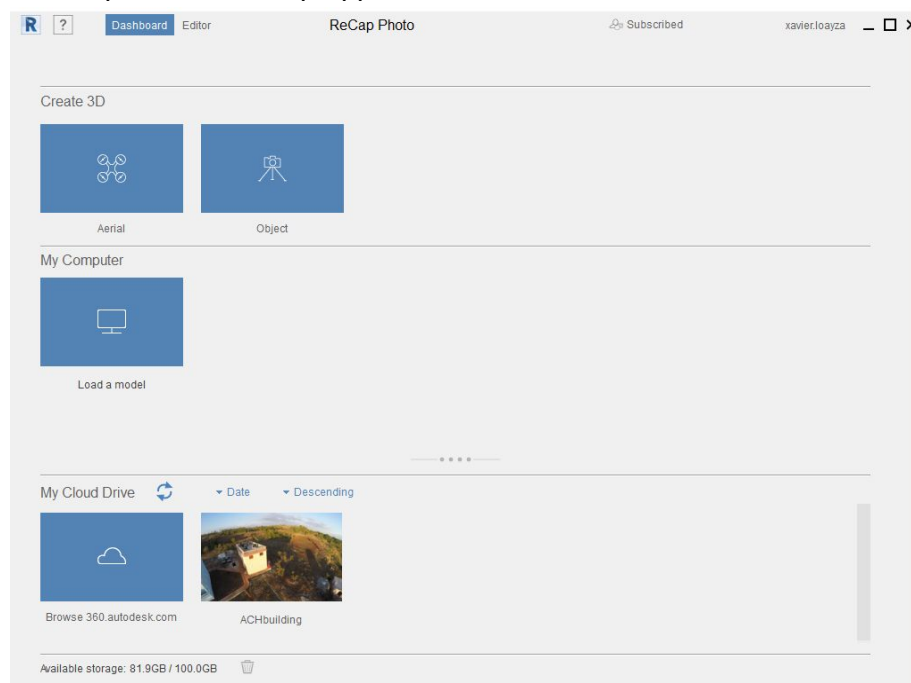
10. The output files will be saved in the project folder. The next figure shows a typical directory structure

2_densification folder contains point cloud and mesh files.

3_dsm_ortho folder contains orthomosaic and terrain files.

Recap 360 workflow

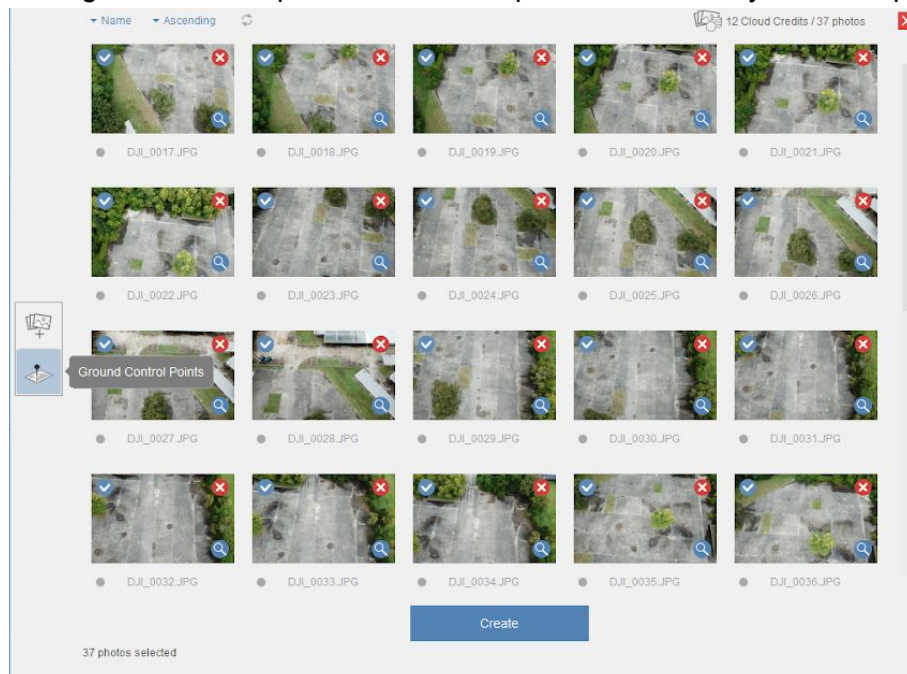
1. Open the ReCap Photo desktop application



2. Start here selecting the type of project



3. Select the set of images (up to 300). If the images are not geotagged, it will warn you.
4. Optional: Add ground control points. This will improve the accuracy of the output



5. Click on Create to enter project, and file outputs, and target coordinate system.
6. Start!

Point cloud into Revit

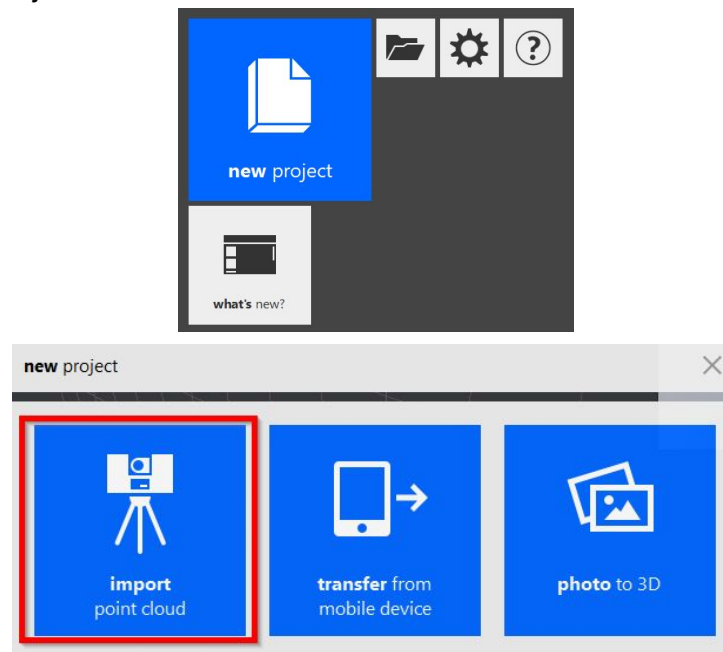
There are a couple of ways to go around importing a point cloud into Revit for visualization. If the point cloud was created in Recap, it is just a matter of opening the file. However, .las files (i.e. from Pix4D) need to be indexed in Revit or converted in Recap into .rcp/.rcs format files.

Point cloud from Recap

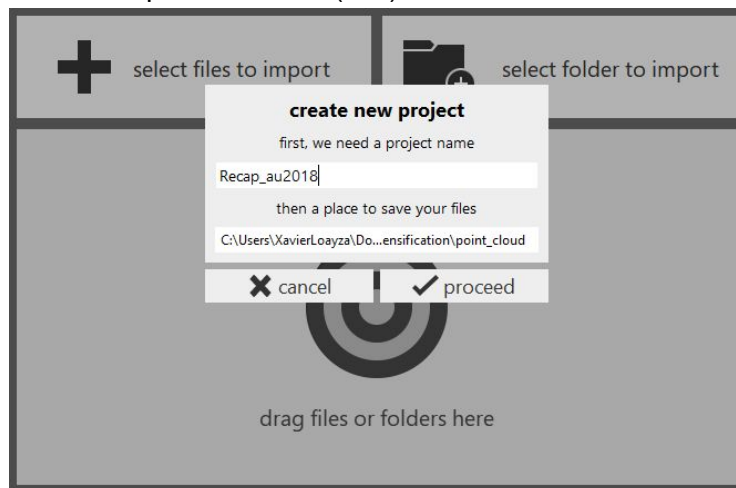
1. Open Revit
2. Insert > Point Cloud
3. Select rcp/rcs file.

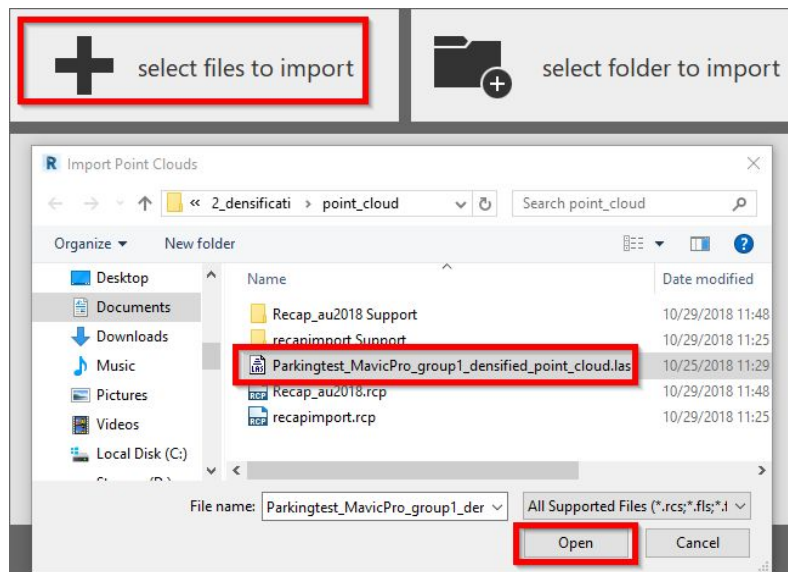
Point cloud from Pix4D

1. Open Recap PRO desktop application
2. Click on “new project”

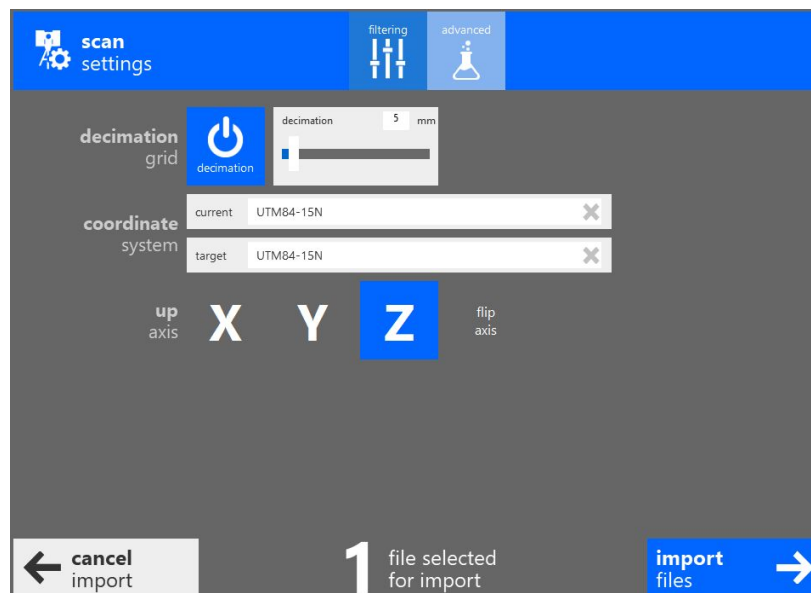


3. Create project and select point cloud file(.las)





4. Open las or generic point cloud file
5. Adjust the preference. i.e. change of units
6. Import files



7. Index scans
8. Launch project.
9. Now, the point cloud files is in Recap format and it is ready to be loaded in Revit

Notice that the previous workflow can be used to append point clouds in a Navisworks file.

UAV

Download .bin/.log files from 3DR Solo

When flying with 3DR Solo, the flight path get stored on board. This is the easier way to download the files without tearing apart the UAV.

General Information

Controller ip: 10.1.1.1

Solo ip: 10.1.1.10

User: root

Password: TjSDBkAu

1. Download WinSCP <http://winscp.net/download/winscp577setup.exe>
2. Create a new site with the following information and login
3. The .bin file are going to be under “log/dataflash”

Publish point clouds to the web

How to publish 3D point clouds to mobile devices and web browsers

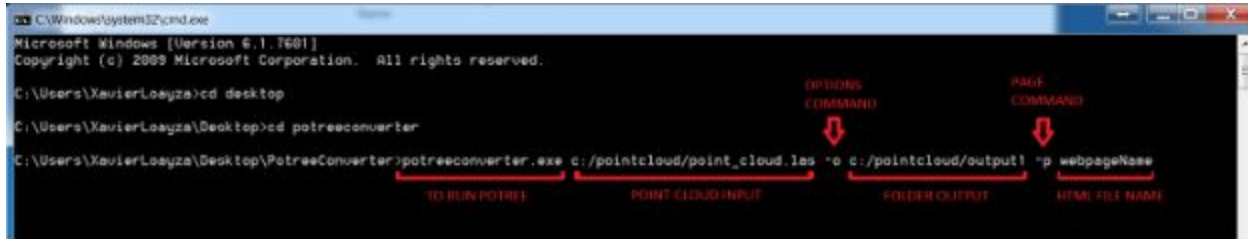
This short tutorial shows how to share 3d point clouds using potree.org, a open source web tool. [Potree Converter](#) converts .las, .laz, binary ply, xyz or ptx files to a format file readable for web browsers.

Steps

1. Download [Potree Converter](#) and extract the .zip file anywhere ie. C:\Users\<user>\Desktop\PotreeConverter\



2. Open cmd to run PotreeConverter.exe

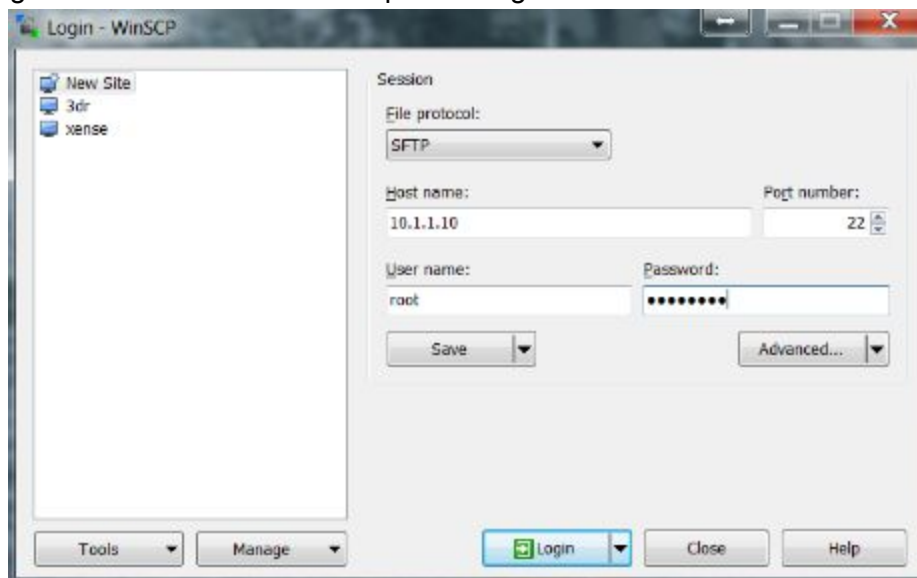


```

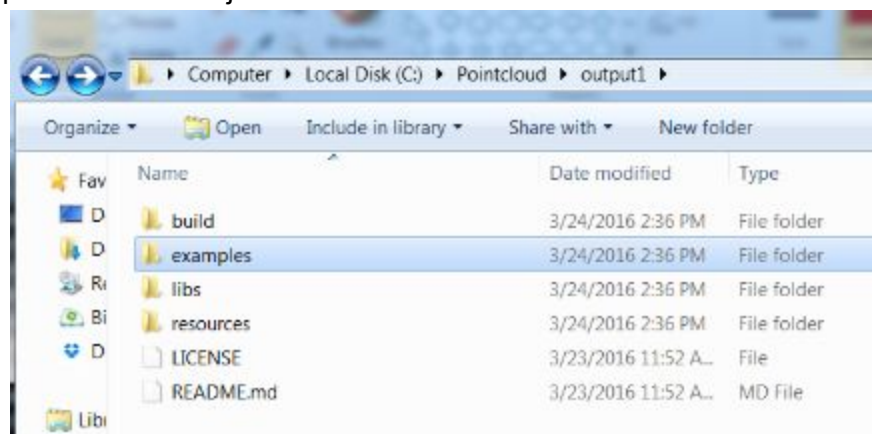
C:\Windows\system32\cmd.exe
Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation. All rights reserved.

C:\Users\XavierLoayza>cd desktop
C:\Users\XavierLoayza\Desktop>cd potreeconverter
C:\Users\XavierLoayza\Desktop\PotreeConverter>potreeconverter.exe c:/pointcloud/point_cloud.las -o c:/pointcloud/output1 -p webpageName
  
```

You are going to see this when it finishes processing



This is the output folder Potree just created

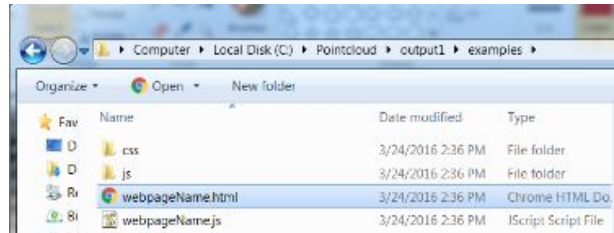


1. If you desire to visualize it as a local file, you are required to create a local server from where you can read the .html file inside the “examples” folder. There are two ways to create a local server: using Python or XAMPP

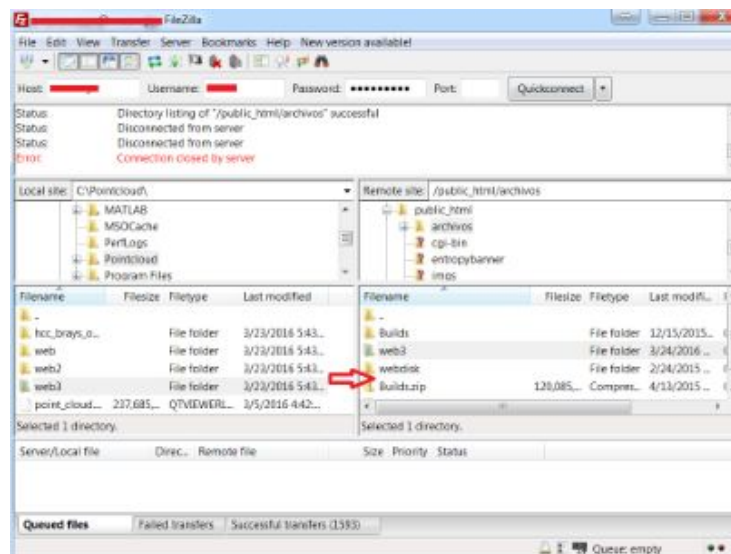
<http://gisdevelopertest.blogspot.com/2015/10/potree-getting-started-tutorial.html>

https://github.com/potree/potree/blob/master/docs/getting_started.md

You will have to move your output folder ("output1" in my case) to where the local server is set up.



On the other hand, we can just upload our output folder to your website or web host. We could use FileZilla to transfer the files.



This is the final result:

