



Grafica 3D per i beni culturali: I tool per multi-view stereo matching

Lezione 12: 27 Aprile 2015

Image-based 3D Reconstruction

□ Advantages:

- Automatic
- Fast (relatively to manual built)
- Good scalability (both small and huge model can be acquired)
- Non-expert users can create his/her 3D model.
- Cheap!

□ Disadvantages:

- Accuracy (not so accurate)
 - Not all the objects can be acquired
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Stereo matching tools, three philosophies

- ❑ Webservice approaches: automatic, no need for powerful hardware, no control on parameters
 - ❑ Local approaches: control on parameters, need for powerful hardware
 - ❑ Hybrid solutions
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Tool 1: VisualSfM

The tool can be found here:

<http://ccwu.me/vsfm/>

It is maintained by Chanchang Wu, a researcher who worked on most of the component for processing.

Tool 1: VisualSfM, install on Windows

To install it on a Win machine, you need to:

- Download and copy the executable from the website: 32bit and 64bit are available. It is possible to use the CUDA version if you have it on your machine. It's only faster in that case.
 - Copy the CMVS and PMVS executable in the same place where Visualsfm.exe is. You can download the files from [here](#) . If you need a 32bit version send me a mail.
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Tool 1: VisualSfM, install on Mac

The installation on Mac seems a bit more tricky, but at least everything needed is installed at once.

Check the installer provided by [Dan Monaghan](#)

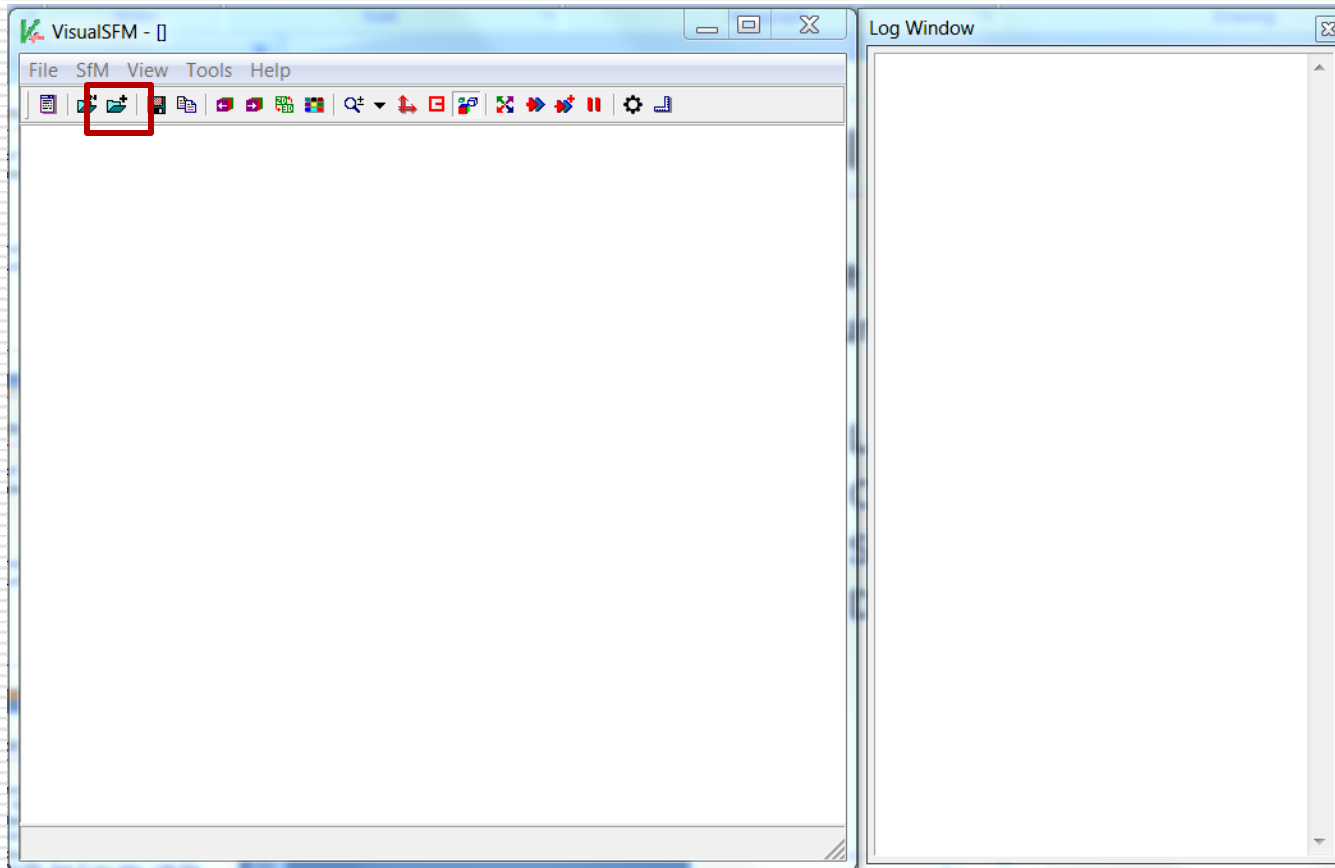
Tool 1: VisualSfM, basic usage

The basic pipeline of VisualSfM is quite simple.
Four steps are needed

- Load images
 - Calculate Match
 - Sparse Reconstruction
 - Dense Reconstruction
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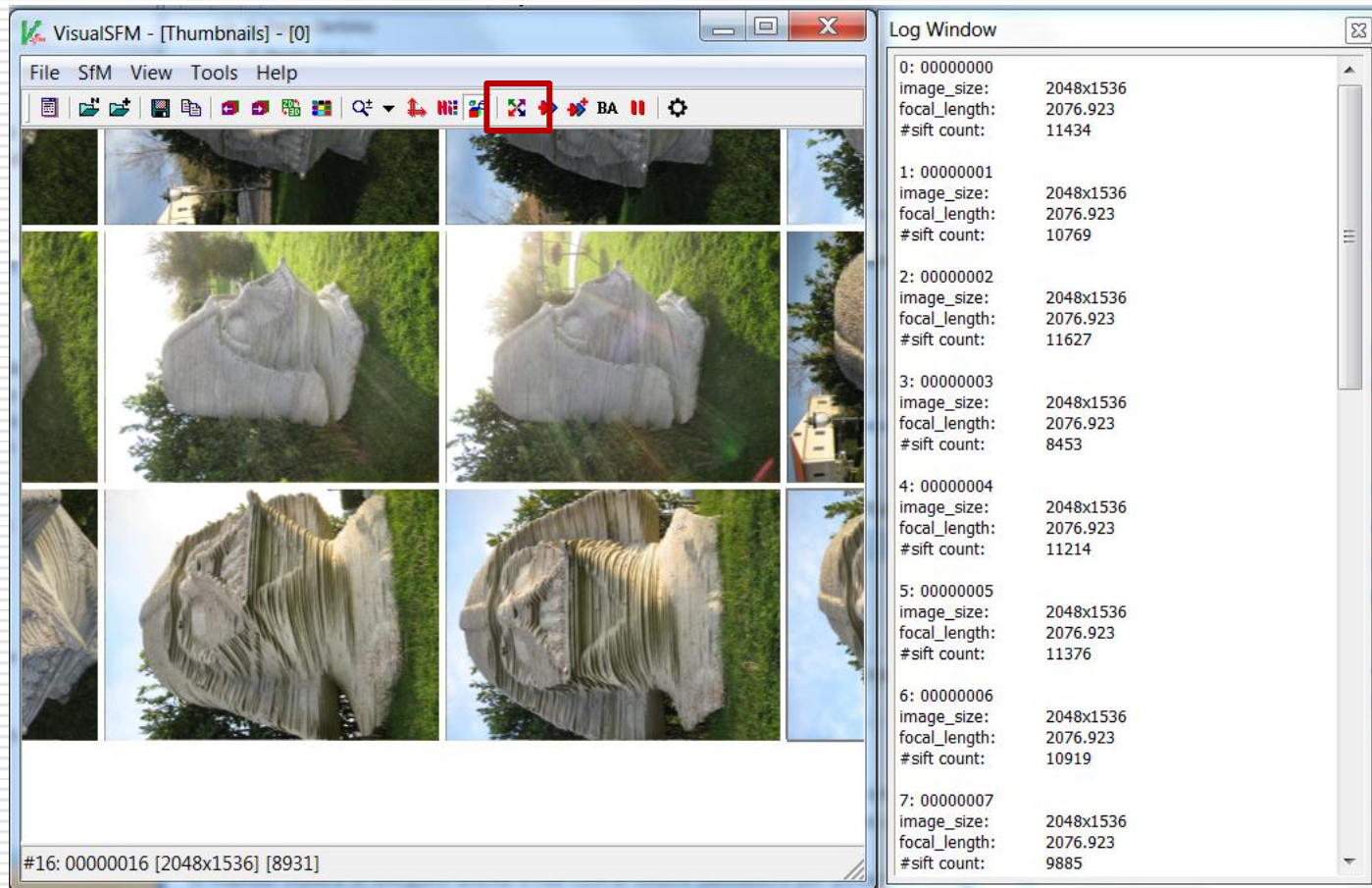
Tool 1: VisualSfM, load images

Select and load the input images



Tool 1: VisualSfM, compute matches

Compute the missing matches



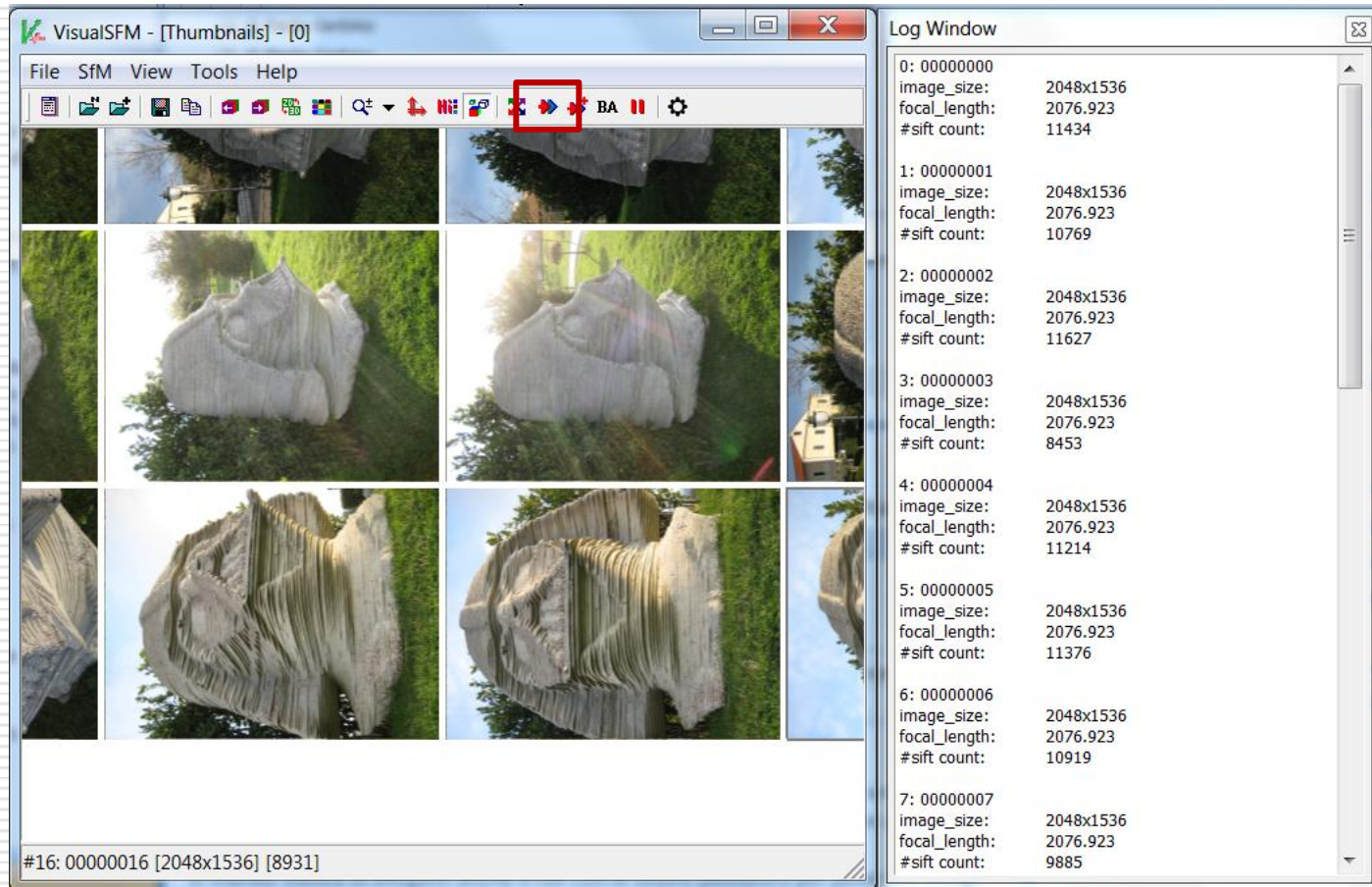
The screenshot displays the VisualSfM software interface. The main window shows a grid of image thumbnails, with a red box highlighting the 'Compute' button (represented by a four-pointed star icon) in the toolbar. The Log Window on the right side of the interface displays the following match statistics:

Match ID	image_size	focal_length	#sift count
0: 00000000	2048x1536	2076.923	11434
1: 00000001	2048x1536	2076.923	10769
2: 00000002	2048x1536	2076.923	11627
3: 00000003	2048x1536	2076.923	8453
4: 00000004	2048x1536	2076.923	11214
5: 00000005	2048x1536	2076.923	11376
6: 00000006	2048x1536	2076.923	10919
7: 00000007	2048x1536	2076.923	9885

At the bottom of the main window, the status bar shows: #16: 00000016 [2048x1536] [8931]

Tool 1: VisualSfM, sparse reconstruction

Generate sparse reconstruction



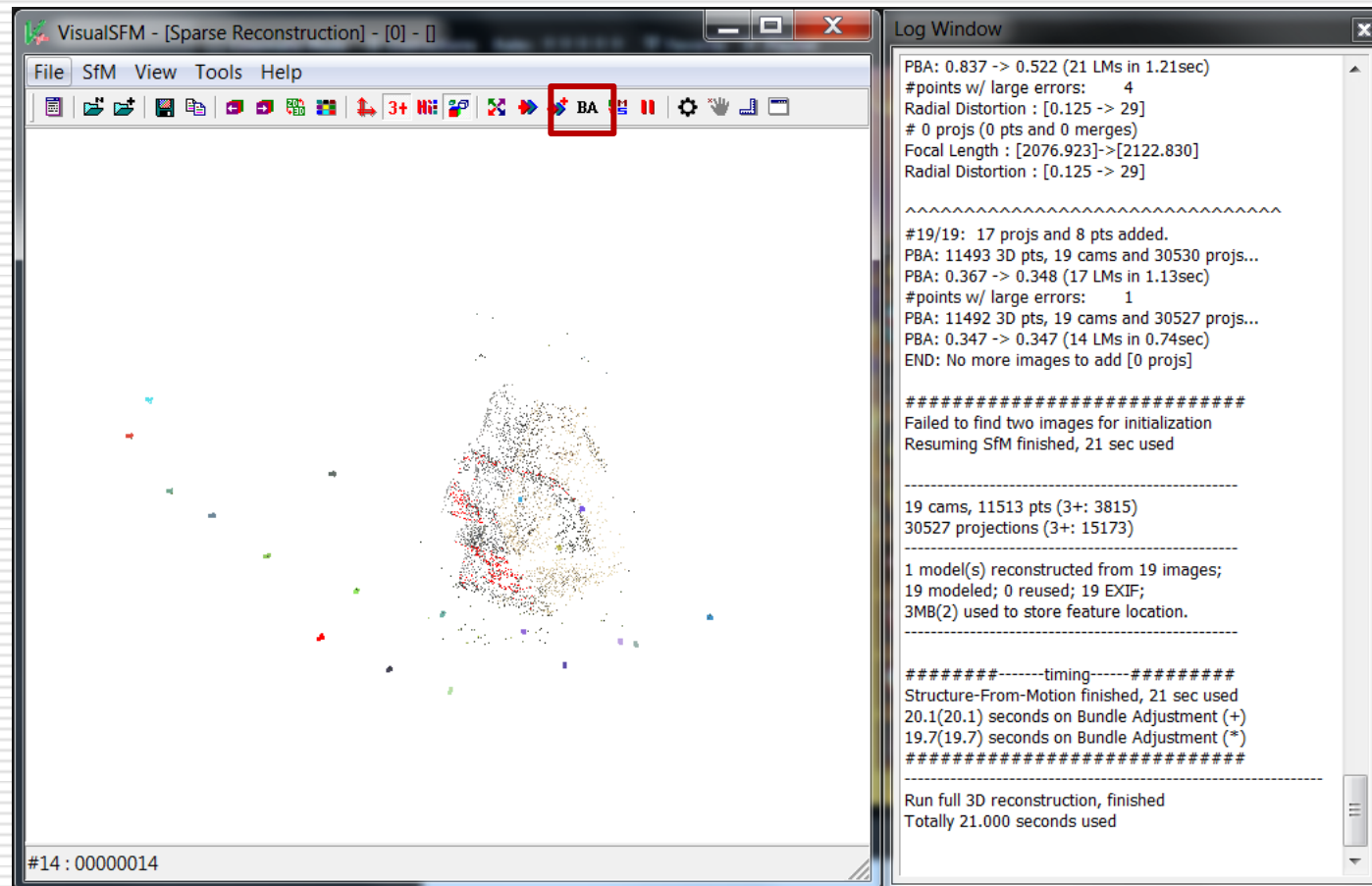
The screenshot displays the VisualSfM software interface. The main window shows a grid of image thumbnails, with a red box highlighting the 'BA' (Bundle Adjustment) button in the toolbar. The Log Window on the right provides technical details for the images being processed.

Image ID	image_size	focal_length	#sift count
0: 00000000	2048x1536	2076.923	11434
1: 00000001	2048x1536	2076.923	10769
2: 00000002	2048x1536	2076.923	11627
3: 00000003	2048x1536	2076.923	8453
4: 00000004	2048x1536	2076.923	11214
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7: 00000007	2048x1536	2076.923	9885

#16: 00000016 [2048x1536] [8931]

Tool 1: VisualSfM, sparse reconstruction

Run the bundle Adjustment to refine reconstruction



Tool 1: VisualSfM, sparse reconstruction

The sparse reconstruction provides an initial feedback about the reconstruction. You can check if:

- All the images have been calibrated (more than one cluster has been created, us PgUp and PgDown)
 - The reconstruction is complete or some part is missing
 - There are wrongly calibrated images
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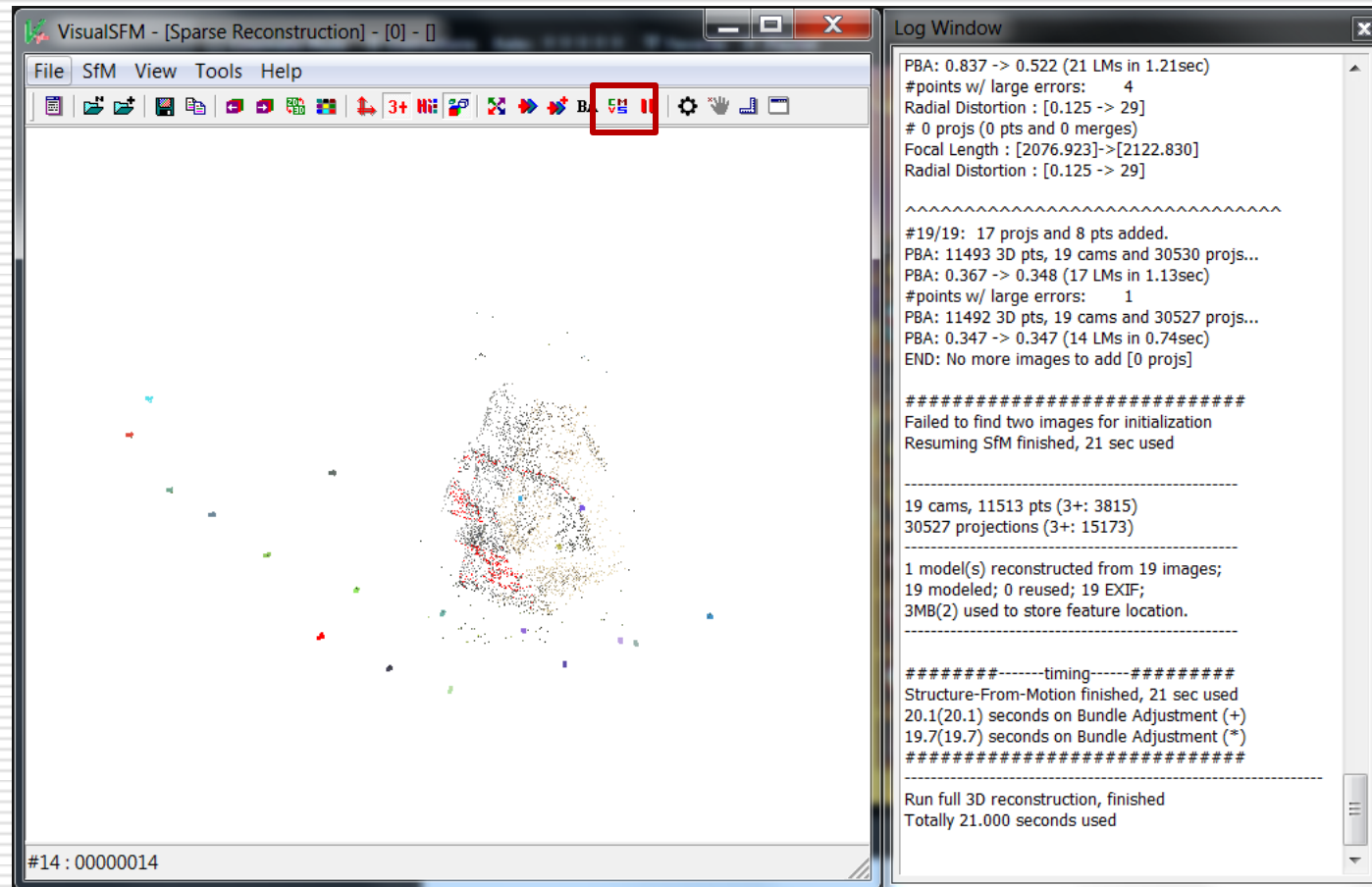
Tool 1: VisualSfM, sparse reconstruction

If the sparse reconstruction has problems you can:

- Change the input dataset (start from scratch, most of the matches will be kept in memory)
 - Remove the wrong cameras (re-launch BA, or try to add them in reconstruction again)
 - There are other ways to control the reconstruction, check the tool!
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Tool 1: VisualSfM, dense reconstruction

Run the CMVS for Dense Reconstruction



Tool 1: VisualSfM, dense reconstruction

The Dense reconstruction ask you to create a new folder (save it where the images are!)

The final Dense reconstruction will be saved in this folder, inside the 00/models folder.

It will be called option-0000.ply

This will be the dense cloud that you will load in MeshLab to create the model!

Tool 2: Arch3D Service

- ❑ This webservice is maintained by University of Siena.
 - ❑ It's focused on Cultural Heritage (the maintainers check the images!)
 - ❑ It's based on a popular reconstruction pipeline (Apero+MicMac)
 - ❑ The input is a bit different: not more than 7 images.
 - ❑ The processing is semi-automatic, and it gives back a dense point cloud (without normals).
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Tool 2: Arch3D Service

- ❑ Website: <http://www.arch3d.org/>
 - ❑ You need to acquire the images and upload them using WeTransfer
 - ❑ Check the instructions to take photos here: <http://www.arch3d.org/>
 - ❑ And the tutorial here: <http://www.arch3d.org/shoot.html>
 - ❑ Since only 7 images are needed, you'll need to change a bit the way you acquire complex objects.
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SfMToolkit

It's the same toolkit as PhotosynthToolkit, but it's completely local

- <http://www.visual-experiments.com/demos/sfmtreekit/>

Good: completely local, no upload, control on parameters

Bad: completely local, sometimes it crashes...

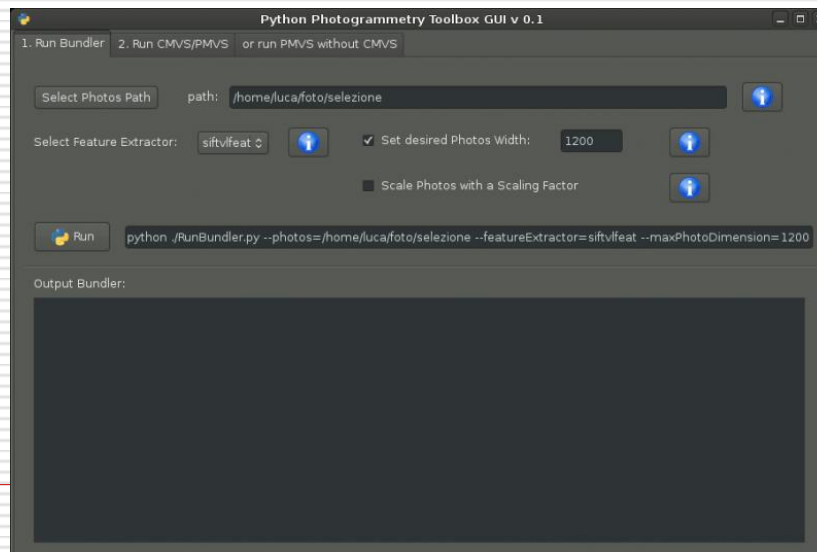
Python Photogrammetry Toolbox

Developed by Arc-Team, open source and free, for Debian and Win (32 and 64bit)

- <http://www.arc-team.com/>

Good: completely local, interface, control on parameters, video tutorial

Bad: completely local, a bit tricky to install...



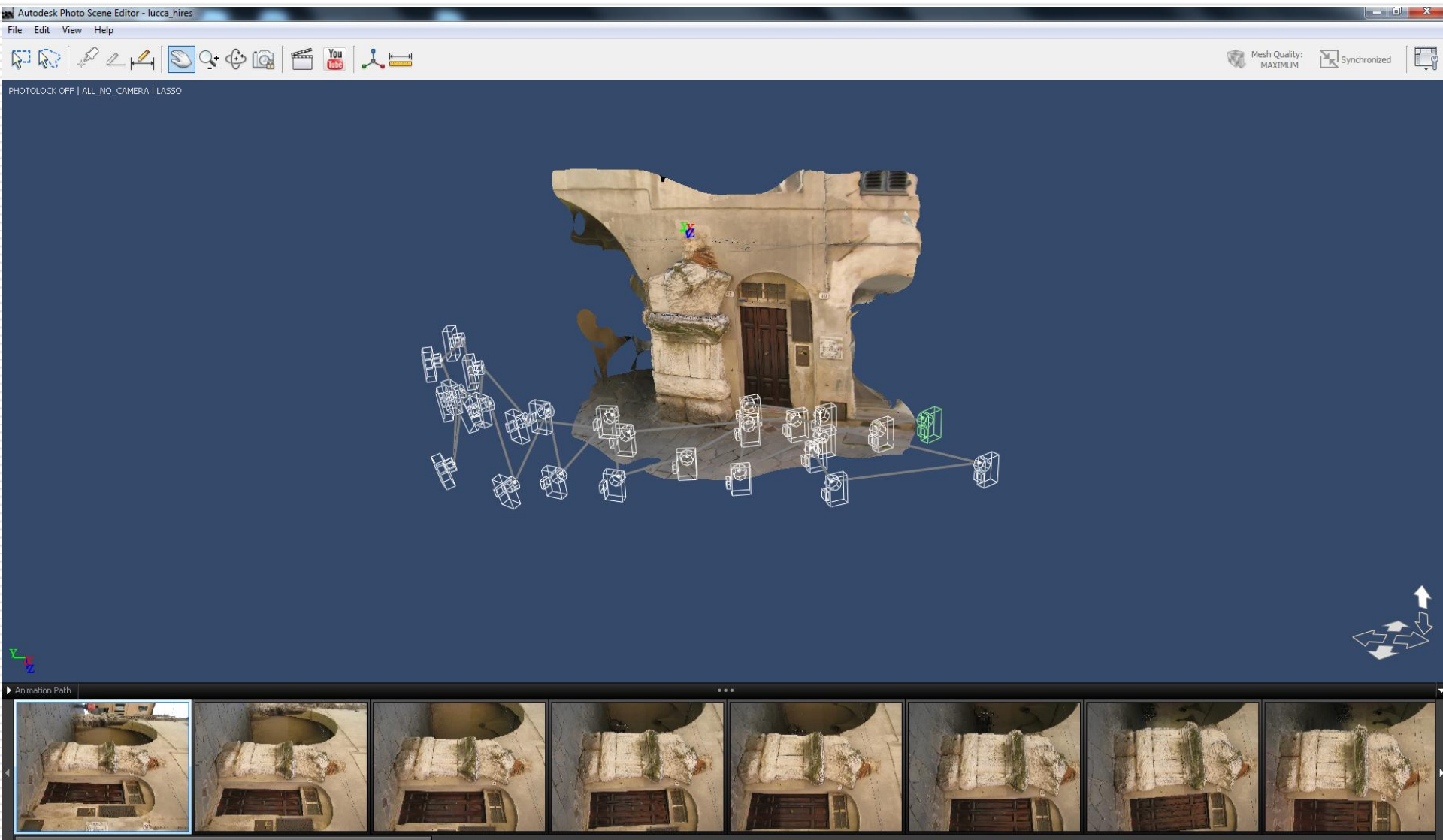
Autodesk 123Dcatch

- Very well engineered tool...
- Works on a remote server, like Arc3D
- Produces a *complete, textured* model
- <http://www.123dapp.com/catch>

It is free (*for now*), and works very very well.

It is fast, works on difficult datasets and the results looks good. However, not really high resolution, and there is less control over the process. It is a good tool to start with...

Autodesk 123Dcatch



Next in line...

Next lesson:

- Multi-View Stereo Matching: creating the model

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