MIT 4.562/502 Fall 2020 Architecture in Motion Graphics Prof. Takehiko Nagakura, rev.: 2020.10.10

Exercise 3: Photogrammetric Modeling and Online Gallery

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Schedule **Class hours of 10/13 Tuesday**: Lecture and demo (photogrammetric modeling)
10/19 Monday: demo (Design Heritage platform and baking texture)
10/26 Monday: Present your work in the class.




Overview: Narrating with 3D captured objects

There is a set of display booths prepared for you on an online 3D gallery platform, Design Heritage. In this assignment, you are asked to collaborate in a team of 2-4 students to make a virtual exhibition on this platform. As means to curate the exhibition, the platform allows you to design a 3D scene for the audience to explore, and to narrate a storyline out of multiple scenes.

Start the project by discussing the theme of your exhibition and what exhibits will be included in your narrative. For the exhibits, each of you are expected to capture a small number of artistic/designed objects along the exhibition theme, and upload them onto the collaborative platform. (Therefore, think of an interesting theme in which each of you can contribute some exhibits even though the team members are located in different countries.) Then by combining your virtual objects with the ones captured by your teammates, design a narrative using the 3D slide show ("Storyboard") function of the platform. Manipulate objects' scale, composition and audience vantage points, so the audience can make a sense out of your spatial narrative. For example, consider the followings:

- From which angle(s) and at what distance(s) do you want the visitor to observe a particular object?
- In what sequence of scenes do you want the audience to experience the exhibits?
- How do you want to relate the exhibits by making specific spatial arrangement(s)?
- What is the appropriate exhibition space and its role for your project?

On a technical side, we use photogrammetric modeling software (Recap Photo or Metashape) to capture/sample real-world objects. Experiment the method by trying to capture different types of targets including

A. a small object such as a sculpture, furniture, or figure.
B. a relatively large surface such as a wall, ceiling or floor.

If necessary, you may also include objects you modeled (in Rhino, etc.) with its texture baked, as part of the scene in your exhibition.

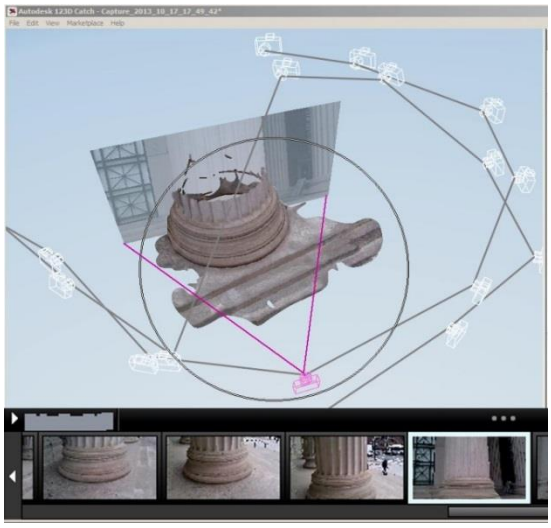
For making of narrative, include annotations by text, illustrations or video along with the 3D objects.

Software for photogrammetric modeling

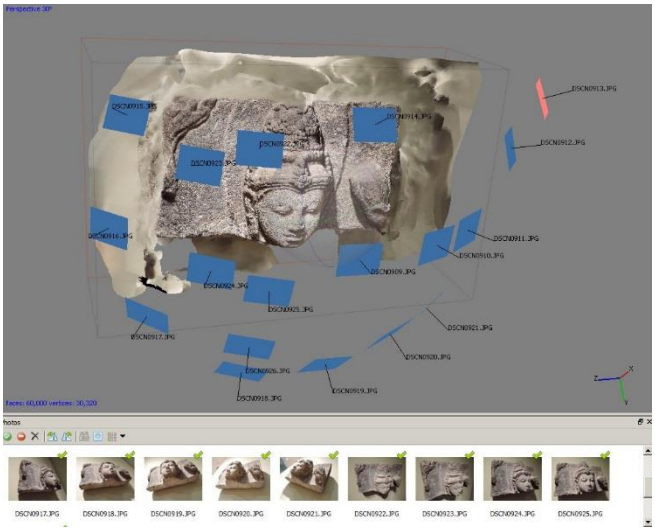
Two options recommended for modeling are **Recap Photo** and **Agisoft Metashape**. See the next section for **Recap Photo** (free from Autodesk), and use the separate handout for quick tutorial of **Agisoft Metashape** ($59 student license or free 30-day trial license).

The biggest difference is that Recap Pro Photo uses Autodesks's cloud-based server, so you do not need a good computer, but no control over the process is allowed and the processing time depends on the congestion of the server. Metashape computes modeling process locally on your computer which must be a good computer (such as one with high-end GPU), and you need to specify many modeling parameters controlling the process by yourself.

Also, the free education version of Recap has a limit to the number of upload-able photos. As of 2020 September, the limit is 100 photos. Metashape has no limit (can go as high as your computer can take).



Recap Photo



Metashape

Basic Steps that uses Recap Pro Photo

1. Install Recap Pro that includes Recap Photo, photogrammetric modeling software. (Link available from the class homepage.)
2. Watch the tutorial video and understand the basics of photogrammetric process. (Link available from the class homepage.)
3. Take photos of each object you selected. (Minimum 20 photos). 30 – 70 photos per object are good number to do this assignment.
4. Check and eliminate obviously bad photos (blurred, un-focused, too bright/dark, etc.) first. One bad photo can screw up everything, so taking a bit of time to do this is very important.
5. Process the photos to a 3D model using Recap Photo. (This cloud-based process may take a while, depending on how busy the cloud server is and how many photos you upload.)
6. Once the model is made, edit/clean-up the model.
   - Orient the model appropriately. (The model may be generated tiled or upside down.)
   - Crop the model to eliminate unnecessary parts.
   - If needed, fill holes. (Your model does NOT need to be perfect for this assignment, though.)
   - If you find some part of the model with too dense mesh count, you can decimate them down to low mesh count.
7. Export the model in .obj forma with a .jpg texture file.

Recommended parameters for exporting to a model suitable for Design Heritage platform is the followings. If the model's mesh count/texture image pixel size is too large, it may crash your computer or work very slow unless you have a very good computer and very fast network connection, even though the larger mesh count/texture image pixel size can contain more details.

- Surface mesh count (Target face count): between 20,000 and 50,000
  Also, enable Y-UP option for convenience.
  * Max. allowed for Design Heritage platform is 180,000.
- Texture size: 2048x2048 or 4096x4096
  * Max. allowed for Design Heritage platform is 8192x8192.

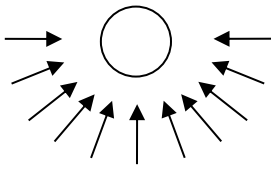
Basic Steps that uses Metashape

Please see the separate handout available on the class homepage.

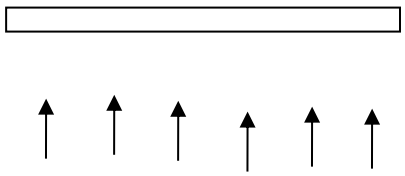
Tips for Photo Shooting

First, watch Autodesk's tutorial videos that are linked from the class homepage. Autodesk's site and Youtube have many videos for Recap Photo and 123D (the former version of Recap Photo), but the principles for photo shooting methods described in these videos apply to both Recap Photo and Metashape. Here are some excerpt tips.

a. If your camera has a zoom lens, do not change the zoom factor for the set of pictures. Keep the same zoom factor.
b. Make enough overlap between adjacent shots. An overlap of minimum 50% or more is preferable. Each portion of the object to be captured should show in at least 3 photos from different angles. This form of photography is different from normal photography that you know. The purpose is to record enough information to create a 3-dimensional model with texture, not to make aesthetically satisfying pictures.
c. Typical way of sampling are here for a free standing object and a large planer surface. The photographic sequence matters. Plan a smooth sequential transition while taking photographs. A small object would require the camera orbiting around it, while a wall would need the camera moving in parallel to the wall.



30-40 photos for covering 360 degrees is good usually. (It means10-15 degrees interval.)



Make sure to have overlaps so every wall portion is seen in at least 3 photos.

d. The number of photos recommended is 30 - 70 per processing (and at least 20 for Recap Photo). (The paid subscription version of the Recap Photo can handle hundreds of photos, but the free version has a limit. Metashape has no limit, but slows down noticeably if you have more than 200 photos in one batch.)
e. You can use any camera including your smart phone camera, but using a camera with good focusing and sharp imaging is recommended. Make a sharp photograph by steadily holding the camera or by using a tripod/monopod. ~~(If needed, you can check these out from TN's lab by~~

~~appointment.)~~ Also, consistent and even exposure is important. Overcast or even light is preferable to high contrast bright sunlight and shadows.
Both Recap and Metashape can use photos of very high resolutions such as 20 megapixels or above. However, Recap requires you to upload the photos online to the server, when photos of high pixel sizes will take you a long time. They also take a longer time to process in both Recap and Metashape. If details are not important, photos under 5 megapixels usually can still make good models. You may also down-sample the high resolution photos in Photoshop before submitting to the photogrammetric modeling software.

f. Depth of field needs to be consistent. In other words, the main target of the capture, such as a column or a wall, should always be in focus in each shot.
g. Transparent or reflective surfaces do not work. Mono-colored surface would need identifiable marks. (You may use removable colored stickers, or clean-able chalk spray for this.)
h. Cropping photographs before submitting to capture processing is not usually recommended, as the context around the target object still helps for the software to align the photos.
i. Clean up a captured model by removing unnecessary surfaces in a few different ways.
    1. Recap Photo has built-in tools for cleaning up surfaces. A good learning resource is the Autodesk video tutorials.
    2. You may import the model into Rhino or 3DS Max and delete unnecessary surfaces. But you should not change the shape of each triangle surface patch as it would distort the texture mapping.

Design Heritage Site

1. Visit the platform and make an account first.
   http://designheritage.mit.edu
   For operational details, please see "User Guide" available through the menu at the bottom of the page.

2. Upload your models into your account. Make sure the model's up-direction is oriented correctly. Include the initial display booths model provided(, or make one yourself).

3. Set up a project for your group's exhibition design, and add your models to the project. In the Storyboard page, you can spatially arrange them into a "state" with a specific view point, and compose multiple states into a storyline sequence.

4. Attach annotations (text, illustrations, videos) using Notes.

References

Links to the following information are available on the class website.

a. Autodesk Recap home page with tutorial videos
b. Autodesk tutorial videos (as reference for method of taking photos for photogrammetry)
c. Examples of photogrammetric models.

Equipment

You may use your smartphone, but for a good result, use of a digital camera is recommended.

~~TN also has a limited availability of consumer digital cameras if you like to check out.~~
~~Canon PowerShot S110 (12MP, no Wi-fi)~~

~~Nikon COOLPIX P340 (12MP/1080p Wi-Fi remote with 5x Zoom NIKKOR Lens)~~
~~Also available are tripods and long mono pods.~~ A tripod is useful if you are taking photos in a dark interior space. A long mono pod is useful if you want to take photos of a large object from high angles. You may need to use a remote when you put the camera to the end of the long mono pod. A combination of mono pod and wifi remote shutter is a very convenient tool in the field.