**MIT 4.562/4.502/4.570/Workshops**
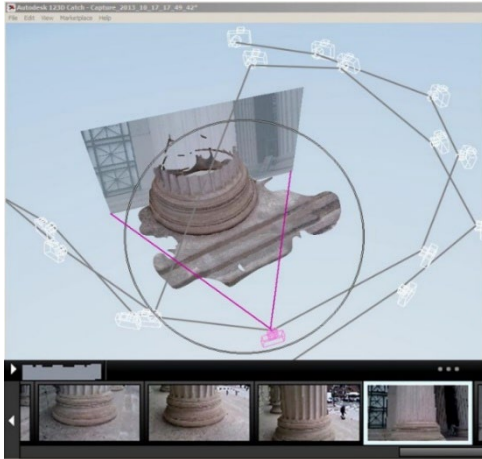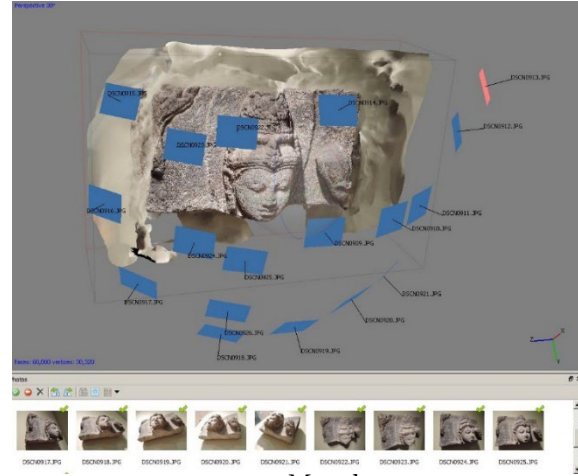Prof. Takehiko Nagakura, rev.: 2026.02.09

**Photogrammetric modeling startup tutorial**

**PART 1: General introduction and Recap Photo**


Recap Photo


Metashape

**References**
Links to the following information are available at the end of this handout ("Useful links" section).
    a. Autodesk tutorial videos (Make sure to watch this once.)
    b. Autodesk Recap home page (software download, demos and tutorial videos)
    c. Agisoft Metashape home page (software download, demos and tutorial videos)
    d. Examples of photogrammetric models.

**Basic Steps**
1. Watch the tutorial video: Get the sense of the basic pipeline and key issues.
2. Take photos of the target space or object (room, object, etc)
3. Install software (recommended: Recap Photo or Agisoft Metashape)
4. Process the photos in the software
    - Import the photos and generate a model
    - Clean up and decimate the model for application (online distribution, Unity 3D, etc)
    - Export the model to standard format (obj or fbx is recommended)
5. Upload the model to posting site such as Design Heritage, Sketchfab, etc.

**1. Watch the tutorial video**
https://www.youtube.com/watch?v=RYM7uZeiXH0
Watch this Autodesk Tutorial Video for Taking Photos. Autodesk's site and YouTube have many other videos for Recap Photo and 123D (the former version of Recap Photo), and the principles for photo shooting methods described in these videos apply to both Recap Photo and Metashape.

**2. Take photos**
Here are some 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 usually necessary for the model generation. 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.
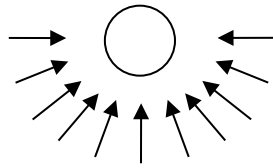
30-40 photos for covering 360 degrees is good usually. (It means10-15 degrees interval.)
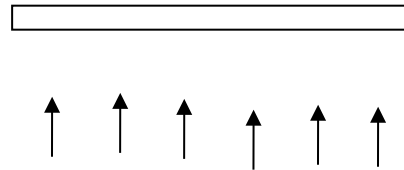
Make sure to have overlaps so every wall portion is seen in at least 3 photos.

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 digital camera with good focusing and sharp imaging is recommended. Make a sharp photograph by steadily holding the camera or by using a tripod/monopod. 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.

### 3. Install software for modeling by scanning

There are three software options recommended for this assignment

Recap Photo: PC software, cloud-based, photogrammetry, digital camera recommended
Metashape:  PC software, local processing, photogrammetry, digital camera recommended
Polycam: mobile phone app, cloud-based, photogrammetry/Nerf/Gaussian Splatting

Two conventional options
Recommended software for photogrammetric modeling on your desktop/laptop computers are Autodesk **Recap Photo** (part of Recap Pro) and **Agisoft Metashape**. **Recap Photo** comes from Autodesk and free for students, while **Agisoft Metashape** is available for free 30-day trial license or at $59 student 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 needs to be a good computer (such as one with high-end GPU), and you need to specify some modeling parameters to control the process by yourself.
Also, the free education version of Recap Photo has a limit to the number of upload-able photos. As of 2020 September, the limit is 100 photos. Metashape has no limit (It can go as high as your computer memory can take).
There are other similar photogrammetry software such as the popular subscription-based software, RealityCapture.

Other option for using high-end smartphones
Alternatively, you may use scanning apps such as ones available for iPhones (some apps take advantages of iPhone depth sensors) and Android phones. The recently popular ones include Polycam and Scaniverse.
If you have an iPhone or high-end Android phone, Polycam is recommended for small scanning jobs. Besides a photogrammetric model, it can create 3D visualization and its exported model through Gaussian Splatting, an emerging alternative to photogrammetry, (and NeRF for visualization). Its free version cannot export the result, but its Pro version is available free for 7-day trial with some limited funcationality.

* For designheritage.mit.edu, you will need to find the apps that exports the model to .obj format, and with only one texture map file.

### 4. Process the model in software
[Agisoft Metashape]
See the section at the end of this handout.

[Polycam]
See the separate tutorial material.

[Recap Photo]
a.  Install Recap Pro 2025 (NOT 2026) that includes **Recap Photo**, photogrammetric modeling software. [As of 2026.02] <u>Recap Pro 2026 version does not allow downloading and editing of the 3d mesh model easily, so do not use it.</u> You also need [As 0f 2026.02]

to download and install **Autodesk Desktop Connector** for keeping and submitting your photos via Autodesk cloud service. (Links to both these software installers are available in the tutorial page of the class homepage.)
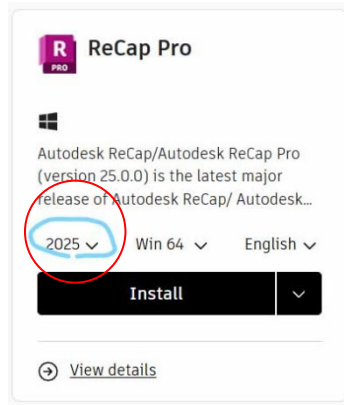


Install Recap Pro 2025 (not 2026), and start with Photo to 3D tool in order to download and edit the 3D mesh generated.
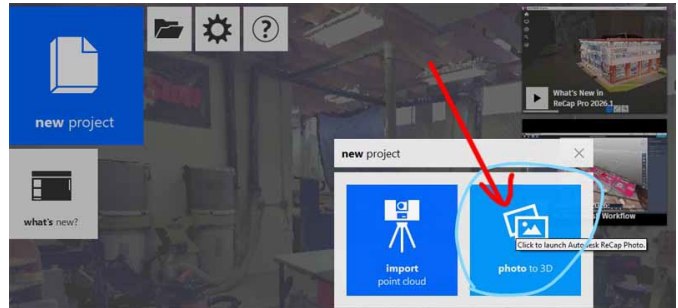
b. If you have not, watch the tutorial video and understand the basics of photogrammetric process.

c. For Recap Photo, photos of each object to generate a model should be minimum 20 photos. 30 – 70 photos per model is a good number to do this assignment.

d. 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.

e. Import the photos to a new project in Recap Photo, and send them to Autodesk's cloud service for generating a model. This cloud-based process may take a while, depending on how busy the cloud server is and how many photos you upload.

f. Once the model is made, it appears listed in the Recap Photo window. You then edit/clean-up the model by yourself in Recap Photo. Here is a tutorial video.
    https://youtube.com/watch?v=ZveVdSil-VE

    - Orient the model appropriately. (The model may be generated tiled or upside down.)
    - Crop the model to eliminate unnecessary parts.
    - If needed, fill holes. (<u>Your model does NOT need to be perfect for this assignment, though</u>.)
    - If you find some part of the model with too dense mesh count, you can selectively decimate them down to low mesh count. For instance, usually a flat surface such as floor and table top gets unnecessarily huge number of mesh triangles in photogrammetry. Decimating a mesh means simplifying it by reducing the number of these triangles while keeping the overall look of the mesh.

g. Export the model in .obj forma (or .fbx format) with a .jpg texture file.
    Recommended parameters for exporting to a model suitable depends on its application. For instance, demonstration in a desktop computer may be able to use a complex model, but a typical AR presentation for mobile phone can not take a large model. For online presentations, a large mesh model takes a long time to download from the server.

    The next section is an example of exporting the model to Design Heritage platform for posting and presenting the model online. For exporting to other applications (AR, VR, game contents, etc.), check the software and hardware instruction of the target. You need to know at least the followings.
        Max mesh count (max # of triangle per mesh and max count of meshes)

Max texture images (max size of each image and max count of images)
Coordinate system: y-up or z-up

**5. Upload the model: Example for Design Heritage platform**

If you are uploading the model onto the Design Heritage platform, follow the guideline below. (If the model's mesh count/texture image pixel size is too large, it may crash your browser 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 5,000 and 150,000
  Also, enable Y-UP option for convenience.
  * Max. mesh count allowed for Design Heritage platform is 180,000.

- Texture size: 2048x2048 or 4096x4096
  * Max. allowed for Design Heritage platform is 8192x8192.

1. Visit the platform and make an account first. The class website (the schedule section) has the updated link for this class.
   For operational details, please see "User Guide" available through the menu at the bottom right of the page.
2. Upload your models into your account. <u>Make sure the model's up-direction is oriented correctly.</u> If not, rotate the model during the uploading as instructed on the uploading page. Omitting this process and leaving a model with improper up-direction will result in difficulty later for your editing/viewing process.
3. Set up a project for your group's exhibition design, and add all of your teammates as editors. Then each member can add your models to the project. In the Storyboard page, you can spatially arrange them into a "state" accompanied by a specific view, and further compose multiple states into a storyline sequence, which can include branching.
4. Attach annotations (text, illustrations, videos) using Notes.
5. [Optional] Place AR-markers in the virtual scenes, and design a physical exhibition setup that includes printed markers.

**Equipment**

For capturing 3D models, 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.
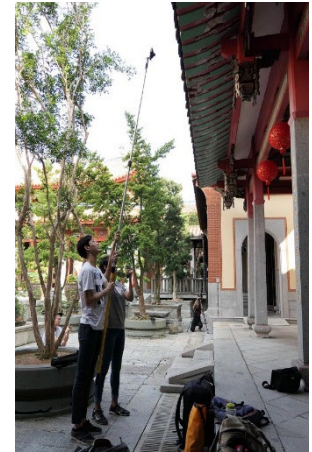
**Useful links**

Autodesk Tutorial Video for Taking Photos
https://www.youtube.com/watch?v=RYM7uZeiXH0

Examples of photogrammetric models
http://cat2.mit.edu/palladio/i_palladio_at_mit/

Design Heritage website (including AR function): Start with USER GUIDE at the page bottom
http://designheritage.mit.edu

Download **Recap Photo** (for photogrammetric modeling) is a part of Autodesk Recap Pro, which is available free for students from
https://www.autodesk.com/education/edu-software/overview

Download **Metashape** (Free for 30 days, or $59 for students. Do not use trial version that does not allow you to save.)
https://www.agisoft.com/downloads/installer/
https://www.agisoft.com/buy/online-store/educational-license/   student purchase page

**Polycam**
https://poly.cam/