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Title: Creation of a photogrammetric model

1 – Aims

The objectives of this photogrammetry tutorial are as follows:

Learning about software that, by means of photographs, can create 3D models.

Knowing what photogrammetry is and its scope of application.

Keeping in mind the recommendations before making a photogrammetric project.

Creating a three-dimensional model from photographs taken with Recap Photo or Regard3D software.

2 – Learning methodology

The teacher will give an explanation about photogrammetry of 15 min.

Students will read this tutorial and watch the video.

Students will follow the steps shown in the video.

They will have to upload the photographs at least 24 hours in advance, so that the model will be available during the explanation.

Building the model in ReCap Photo.

Creating the point cloud in CloudCompare.

Use ReCap to save with .rcp format.

Open the model in Revit (this step is not mandatory).

3 – Tutorial duration

The practice described in this tutorial will be carried out in a computer classroom.

It will last 3 teaching hours.

4 – Necessary teaching recourses

Computer room with PCs with Internet access.

Software required: ReCap Photo, CloudCompare, Regard 3D (optional), Revit (optional).

Hardware required: PCs, camera.

5 – Contents & tutorial

5.1 – Introduction

Photogrammetry is a technique by which accurate information about the dimension, shape, and position of objects in space are obtained by means of photographs.

It can be applied in various areas such as: agronomy, topography, cartography, archaeology, architecture, engineering, 3D printing, among others.

5.2 – Object to model

With this tutorial we are going to model a park monument using Photogrammetry. Specifically, we will get its point cloud.

The work is located in a Park called Italia in Santo Domingo, Dominican Republic. It represents the flag of each country by two interlocking rectangles. It is shown in the next figure.

To make the model, 43 photographs were taken with a smartphone camera. Furthermore, the distance between two reference points was measured.

5.3 – Software installation

Two different software will be needed to carry out this exercise. The first one is ReCap, belongs to the Autodesk family. The second one is CloudCompare, a free software.

For ReCap, please go to the Autodesk website and create an account: https://www.autodesk.com/. Once you were logged, look for ReCap Pro, and at the moment of its installation, choose you are a student. The platform will ask us to confirm this information in order to access directly to the software that can be downloaded

https://www.autodesk.com/education/edu-software/overview

When the installation is completed, two programs will appear on the desktop: Autodesk ReCap and Autodesk ReCap Photo.

- For CloudCompare, you don't need an account. You just have to go to the following link, and click on *Download* and choose the last version:

https://www.danielgm.net/cc/

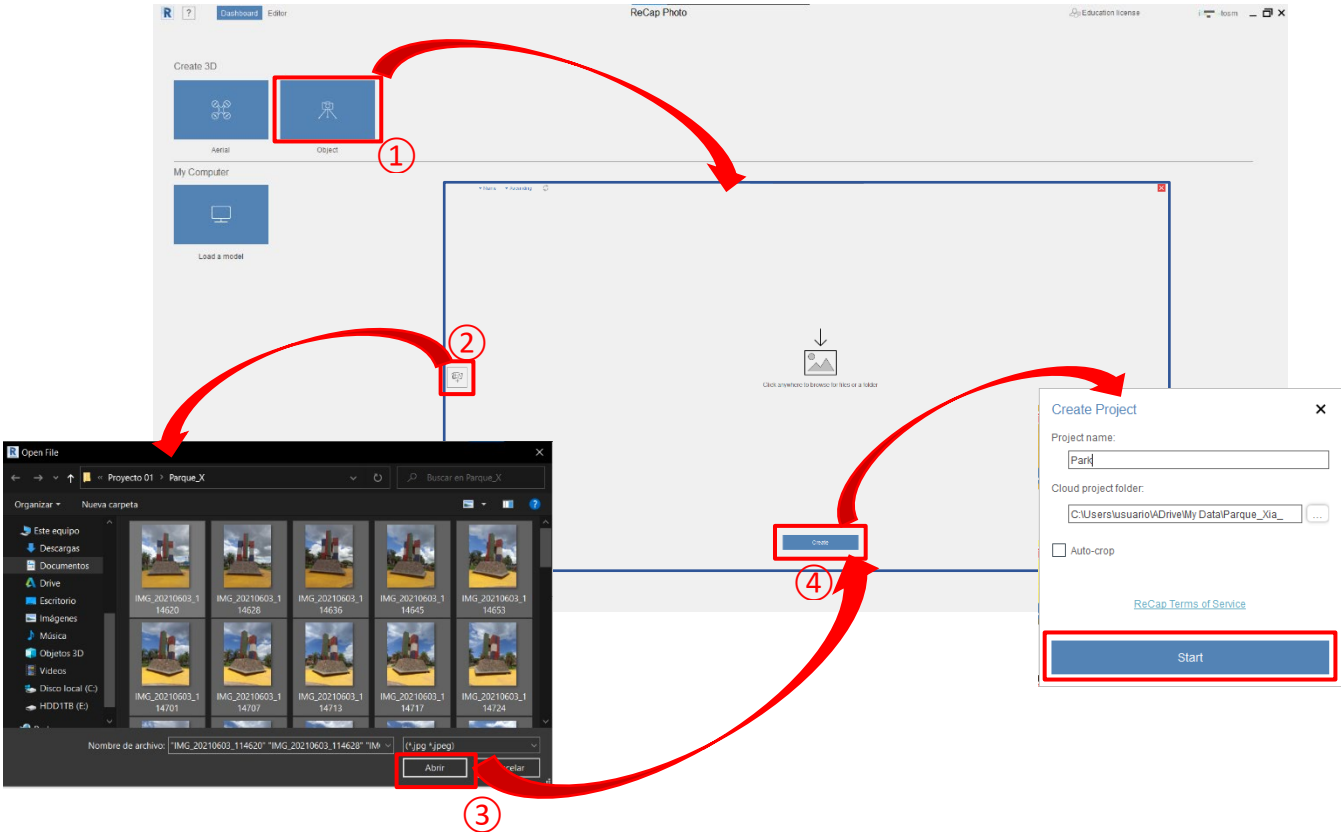
5.4 – Beginning

5.4.1 – ReCap Photo

Photogrammetric restitution must be first created. This is a process over which we have no control. It's carried out automatically through Autodesk ReCap servers. You just have to select the photos of the model

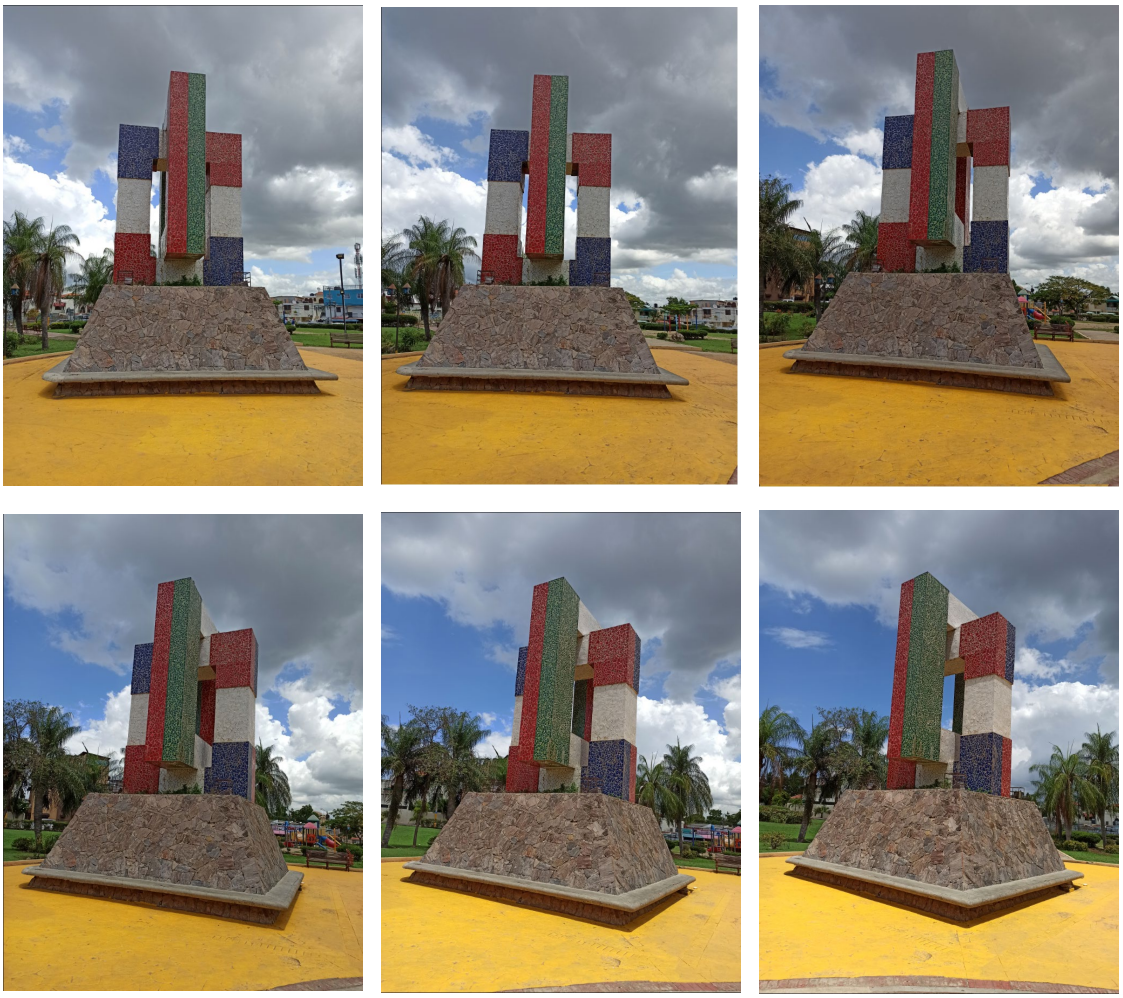
Quick tip: This process takes a long time to get the model. It may take 8-24 hours to be available.

Open ReCap Photo and click on *Object*. Then, click on *Add photos* and choose them. Go to *Create* and, in the *Create Project* pop-up window, name the project and choose its location in the *Cloud Project folder*.



Recommendations for taking pictures:

- They must be taken using the same camera lens to keep its focal length. If you have a multi-camera phone, you will have to use the same camera lens to take the photos.
- Take photos on cloudy days to avoid shadows and loss of information. If it is not possible, take them at noon when the sun is at its highest point of elevation (zenith).
- Have a moderate distance from the object.
- At least 20 photos are needed.
- Keep relation with the previous picture, that is, have common areas between one photo and another.



The 3D model obtained corresponds to a mesh, not a point cloud. It must be transformed into a point cloud if you want to export it to Revit or Advance Steel. For this process, CloudCompare will be used.

If there are areas in the model that did not look good, it is due to a lack of information.

The steps are the following:

- Cleaning: we proceed to erase everything that is not part of the model, such as the ground, trees and white areas by means of the *Selection* tool.
- Rotate: Place the main face on the X axis with *Transform model*.
- Scale: Size the model to the actual measurements with *Set scale & units*
- Export: Save the model in FBX format with *Export model*.

5.4.2 – CloudCompare

To create the point cloud, open CloudCompare and load the FBX model. Then click on *mainMesh* to enable some options

Click on *Sample points on a mesh*  and accept the default options. With the previous step, you can set the number of points you want to extract from the mesh.

The point cloud already appears and is called *mainMesh.sampled*, below *mainMesh*. It must be saved in e57 format. This format is compatible with Autodesk ReCap.

5.4.3 – ReCap

Open ReCap and go to *New Project*. Click on *Import point cloud*, name and choose its location where it's going to be saved. *Select files to import* and click on: *Import*, *Index* and *Launch*

The point cloud must be saved in .rcp format. This format is compatible with Revit and Advance Steel.

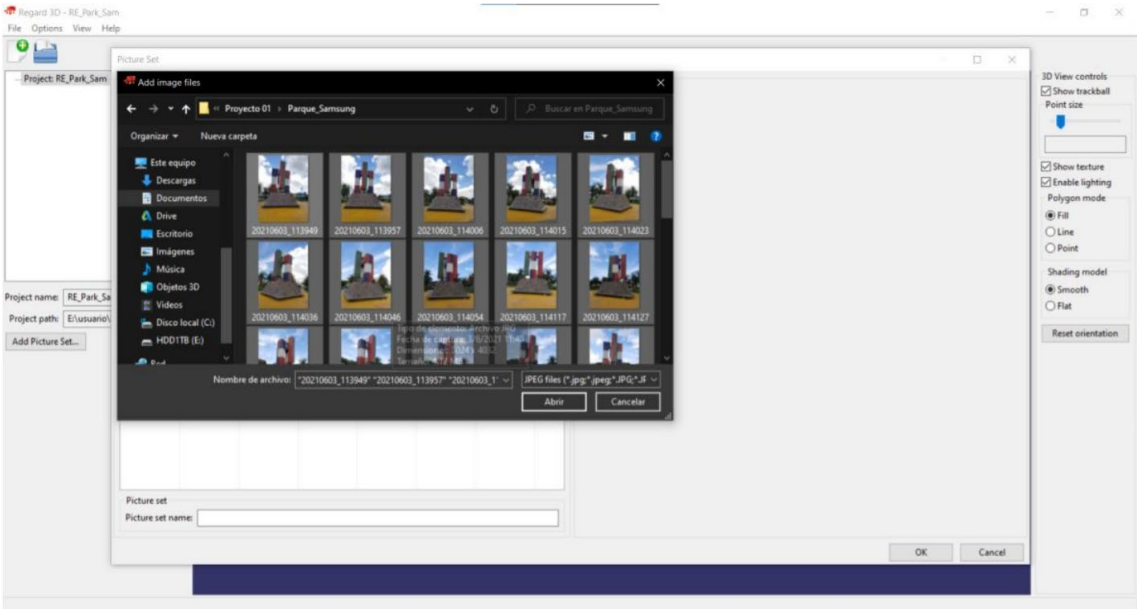
5.4.4. – Regard 3D

This is a free and open source software to make 3D models from photographs. It is easy to understand and has a minimalist interface.

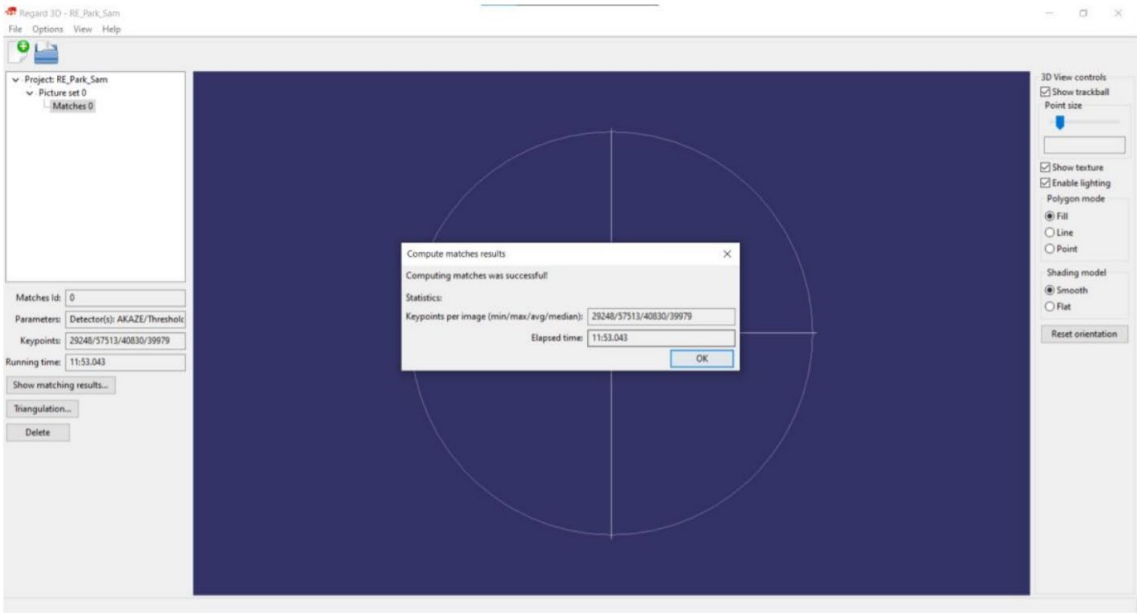
It can be used to create the point cloud and also the surface of the model.

Although the steps using this software are not shown in the video, the process would be as follows:

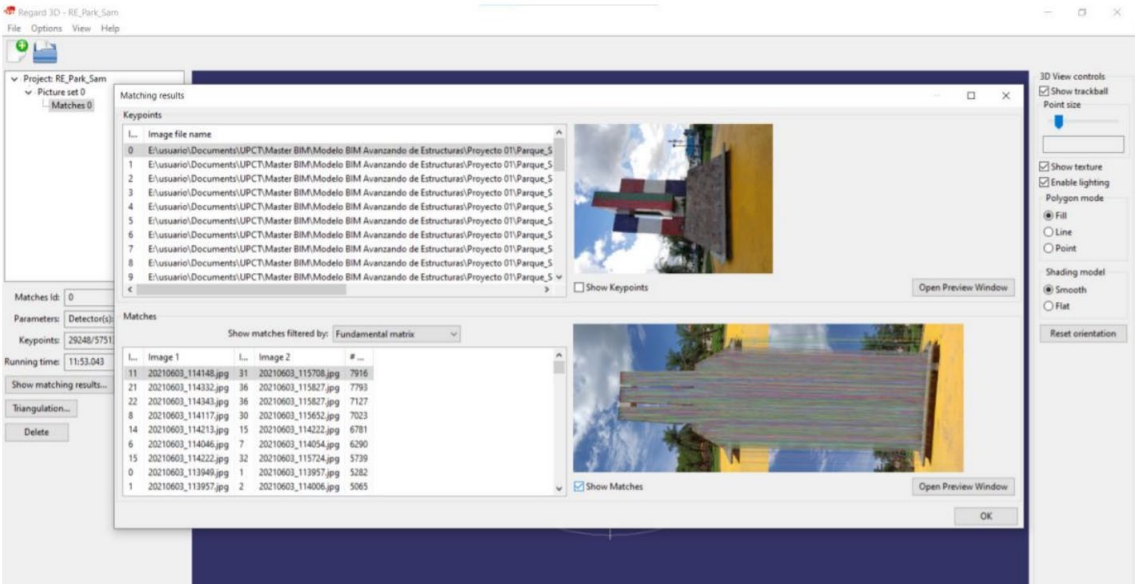
- Create a new project through: File > New Project. Select the photos.



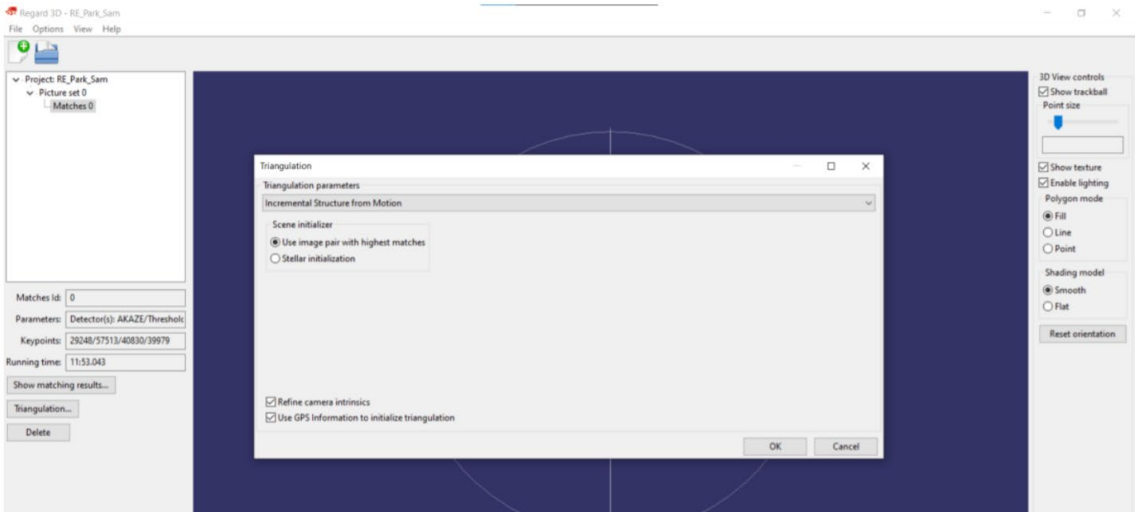
- Set the Parameters of *Keypoint sensitivity* to 0.0005 and *the Keypoint matching ratio* to 0.7.

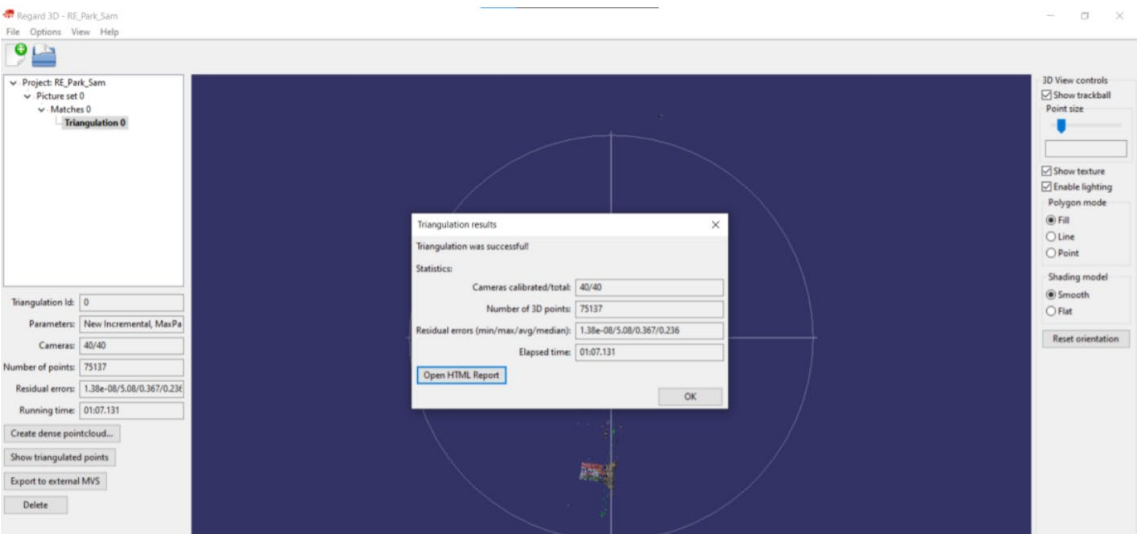


- Matches between points:



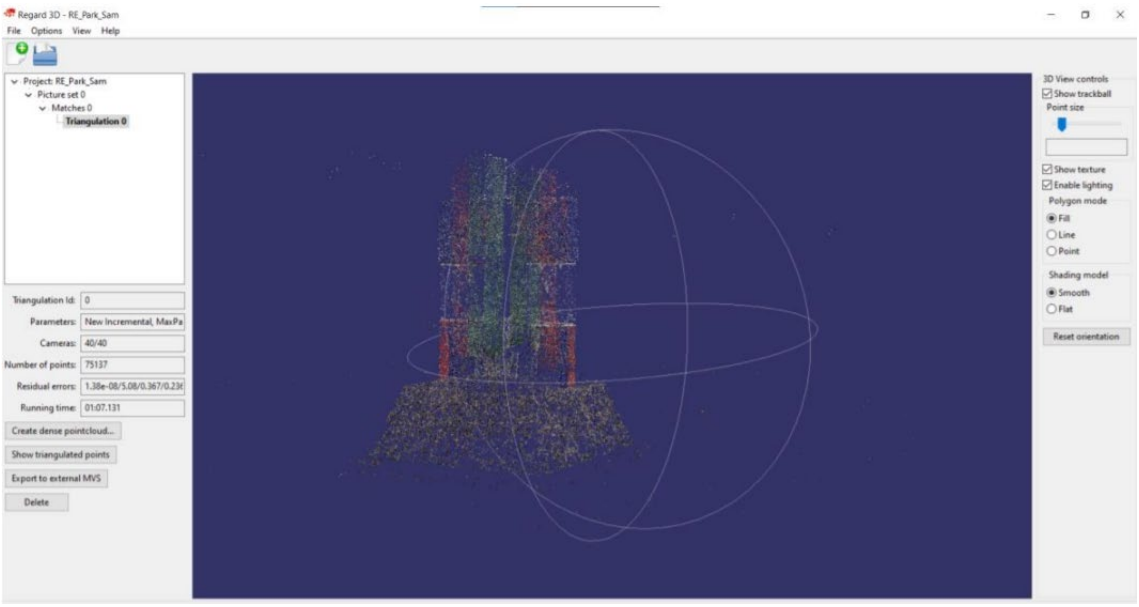
- Parameters of triangulation:



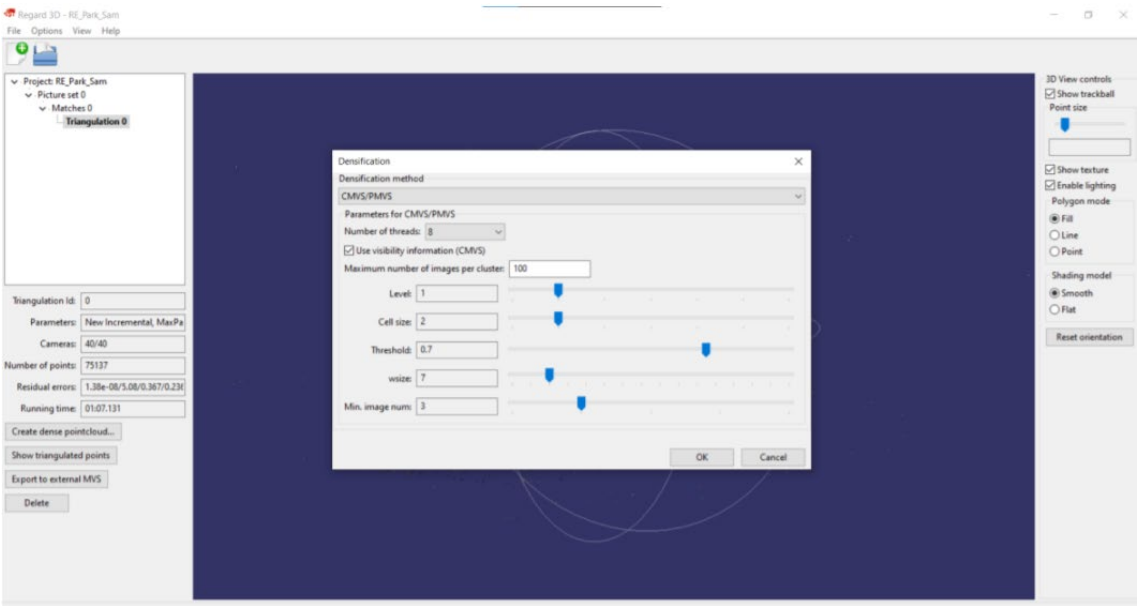


Points returned: a total of 75.137. The photos were taken with a Samsung Galaxy S8. An attempt was made to create another model of the same work, but in this case the photos were taken with a Redmi Note 8 Pro. The time to compute the matches exceeded 55 minutes and the total number of points was over 240.000. Therefore, it was decided to continue with the Samsung photos

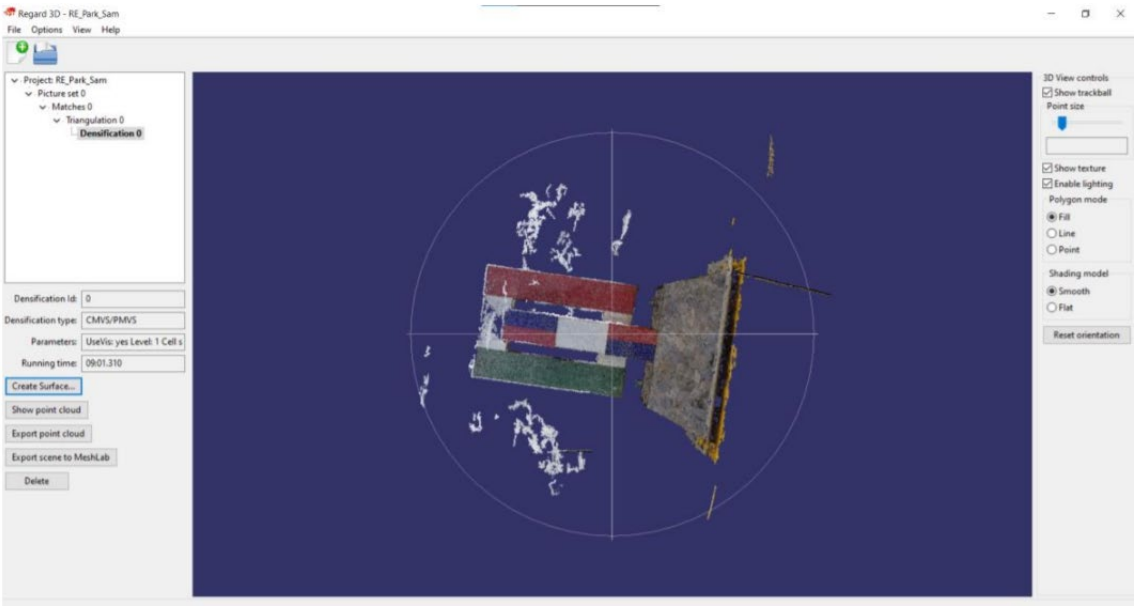
The model is shown:



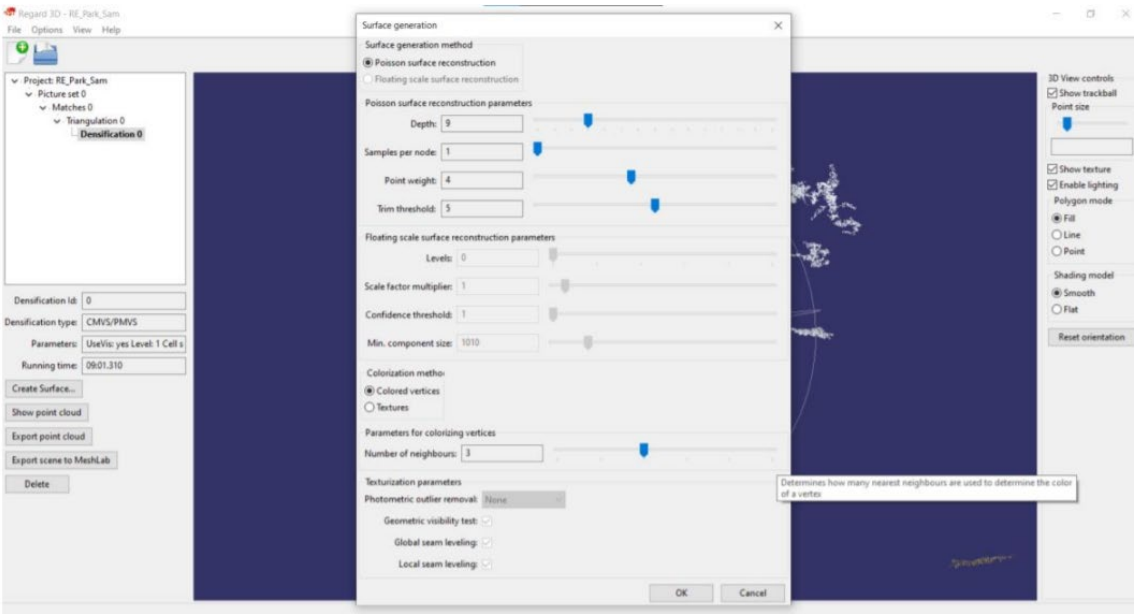
- Parameters to densify the point cloud:



- Process completed:



- Creating a surface from the point cloud:

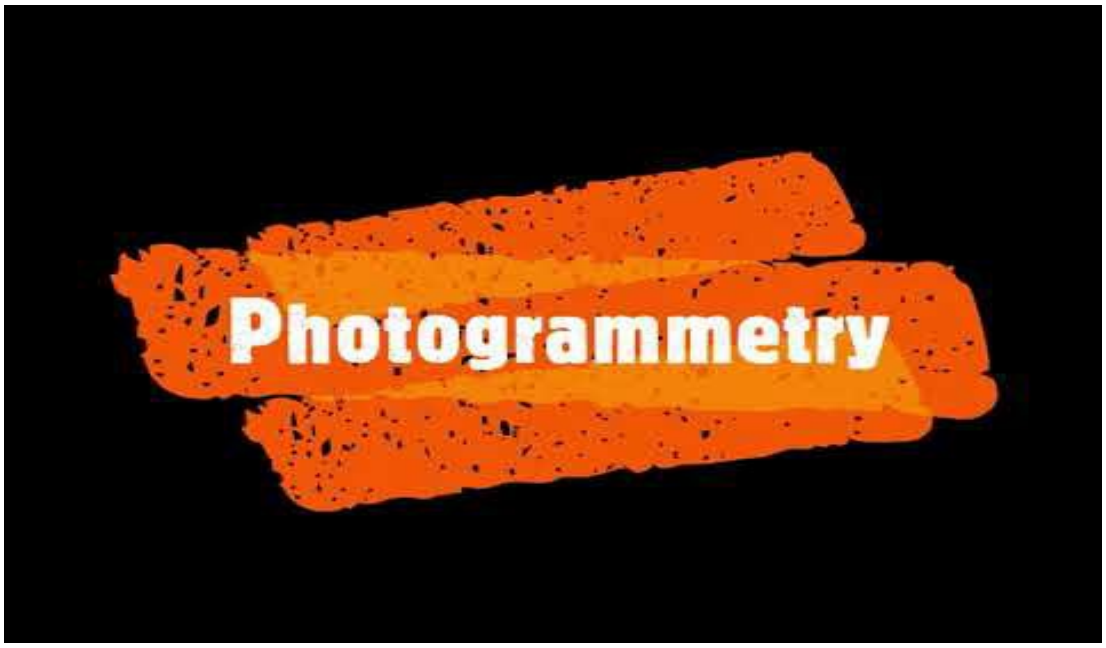


5.5 – Video

A video will be shown that explains in detail how to create a photogrammetric model.

The video uses ReCap Photo to create the model, CloudCompare to obtain the point cloud, and ReCap to save it in .rcp format.

https://www.youtube.com/watch?v=FotfvTRLrBU



6 – Deliverables

To assess the achievement of the practice, students will write a report of 3 pages maximum.

In this report, the student will explain the steps taken in practice, the difficulties found and the decisions taken. The report will be illustrated with photographs during the process of each software.

7 – What we have learned?

To create a photogrammetric model using ReCap Photo and Regard 3D.

To obtain the point cloud from a photogrammetric model in CloudCompare.

To export the point cloud to RCP format using ReCap.

To export a photogrammetric model to STL format.

To visualise the model in Revit (optional).

8 – Files to use in this tutorial

Photographs of the model to be made

Model made in ReCap Photo (.rcm format)

Model made in ReCap (.rcp format)

Point cloud (.e57 format)