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BLOCK V: New BIM Modelling Technologies 3D scanning and BIM models, photogrammetry 3D modelling and 3D printing.

Title: Terrestrial Photogrammetry

1- Aims.

To know the digitization by means of photogrammetric capture.

To know the necessary procedures to carry them out and to be able to apply them.

To know the limitations of this methodology in its terrestrial form.

Show different cases according to the element to be documented exposing the adaptability of the technician.

Showcase modern processing software that is affordable and open to free processing of information and content.

Final obtaining of the photogrammetric result, with a point cloud and a polygonal mesh.

2- Learning methodology.

Students will read this tutorial and watch the video.

The content of this theoretical-practical video, is focused on the student can know several conventional terrestrial photogrammetric technologies in addition to their methodologies of action; showing the handling of attitudes and digital tools that the photogrammetrist technician must learn.

In order to favour the understanding, different aspects of the tools used that may be of importance for their handling are explained, while the explanation is developed by means of 3 practical examples that recreate different situations both in field work with tasks and procedures

that the technician must carry out, and in office work with its corresponding data processing and obtaining three-dimensional elements.

In order for the teacher to evaluate the use of the practice, each student will write a report and will hand in his photogrammetric model as well as the photographic and georeferenced information if there is any.

3- Tutorial duration

The practice described in this highly practical tutorial will be carried out by capturing elements near or belonging to the training centre, such as a room, a tool or a set of pillars. The duration of the tutorial is variable, and can range from 4 hours of practical application of field and office work to more than 12 hours depending on the element captured and the computer components with which the data is processed.

4- Necessary teaching resources.

Digital Camera, Reflex Camera and Smartphone.

Computers compatible with RealityCapture requirements.

64bit machine with at least 8GB of RAM.

64bit Microsoft Windows version 7 / 8 / 8.1 / 10 or Windows Server version 2008+.

NVIDIA graphics card with CUDA 3.0+ capabilities and 1GB VRAM.

CUDA Toolkit 10.2, minimal driver version 441.22.

5- Contents & tutorial.

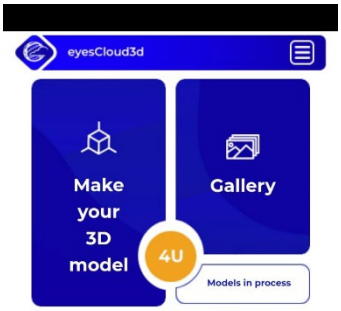
5.1- Case study 1:

Smartphone:

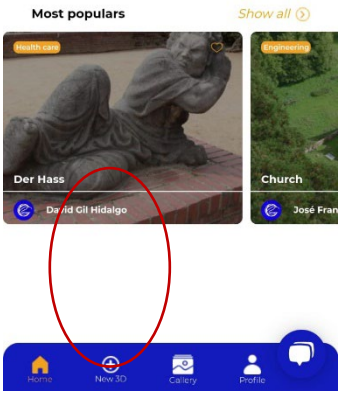
Smartphones have become an indispensable element in our lives, where sometimes it can be difficult to see them as working tools, the truth is that they are very recurrent devices where it is

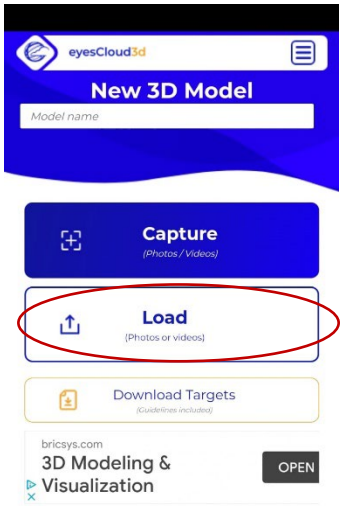
possible to support disruptive technologies, which is why more and more cases are being investigated on photogrammetry applications, videogrammetry or laser scanner using smartphone.

- **Installing the app:** We access our mobile terminal smartphone open the download program Playstore or App Store, look for Eyescloud3D and install it, once installed on our terminal, we initialize it and accept the terms of use and register an account with our email to use the app without further problems.
- **Capture and processing:** The data capture must be done previously with the conventional and own application of the camera smartphone, the data must be within the parameters.
  - Maximum 1 minute of video, being able to record several clips but without their total length exceeding one minute.
  - Maximum 50 photographs.



The enhancement is then initialized





At the top there are icons that redirect you to the processing tab or to the gallery of your creations.

In the center we find a lower panel with various options, such as the processing tab, gallery or profile.

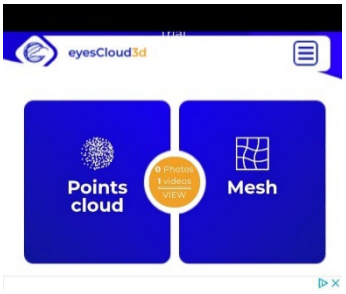
The processing tab can be accessed using the icons shown below.

We access the edit menu where we must select the "Load" option to access the phone's camera gallery.

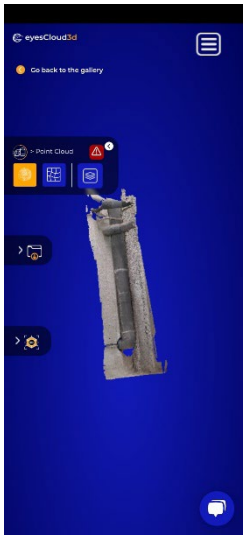
It is now possible to add a title to the project, in the upper white bar where you can read "Model name".

We select the content we want to process. Photographs or video. The formats cannot be combined, it is only possible to process photographs in the same model or videos in the same model.

Once the content is loaded into the platform, click on the central icon with arrows.

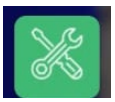


Once the process is finished, the following panel will appear, which will give us the option of accessing the point cloud or the polygon mesh.



The top drop-down panel shows the option to switch to point cloud or polygon mesh view.

The bottom drop-down panel displays the option of a large number of tools.



If we select the following option we will have access to tools of great informative utility represented in the video such as:

Insert notes: Mark and select points with a note and information.

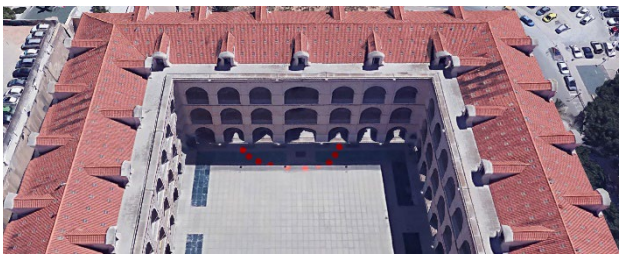
Trim: Removes unneeded or defective elements from the model.

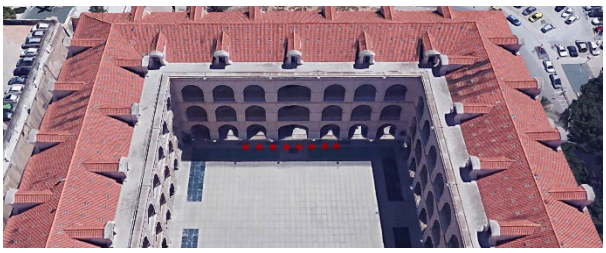
5.2- Case Study 2:

Space capture:

- **Data capture:** The capture of a space, is based on the continuous photographic taking by superimposition from different distances and angles, in order to obtain information such as measurements that the program will perform later to obtain measurements and approximate dimensions.

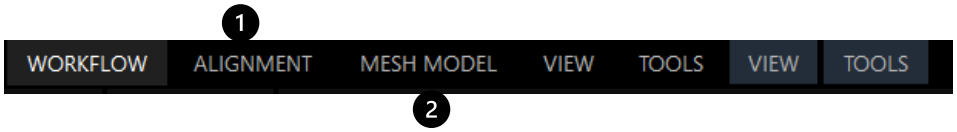
  The routes can be straight or circular, in this case we have used a rectilinear route with several photographs per station, which means that the technician will take photographs located parallel to the canvas that he wants to capture taking from each position several photographs of the environment collecting great information of the exterior of the structure mainly, another route practiced is the semicircular used to capture the interior and exterior of the arches and vaults achievement.





- **Software installation:** The Reality Capture software is installed from its website https://www.capturingreality.com/DownloadNow It is necessary to register to use it, because although the information processing and editing is free, if you want to download the photogrammetric project, you must pay a small fee. It is possible to register using Google Account, Facebook or your Epic Games account if you have one.

- **Processing with Simulated Error:**



Beginning with the settings, it is advisable to set the *Image Overlap* to *Low* or *Medium* if you have not taken a large number of ALIGNMENT photos.
In the example a photogrammetric capture with 85 photographs is prepared, where we obtain a good point alignment of the façade with passing arches, so we proceed to the next step of the Workflow.

We continue the processing by selecting the section where MESH MODEL we will obtain the polygonal mesh of the point cloud by joining these, which act as vertices of the polygons generated. When we obtain the three-dimensional model, we can observe various conditions that the polygonal mesh has, for example:

1. At the distal ends of the arch the quality is lost, while it gradually increases towards the central arch with the gate. This is due to the fact that this was our capture objective, so the rest are residual point creations.

2. We must take into account that the photographed element is composed of 2 clearly recognizable spaces, firstly the exterior area of the façade with arches and secondly the interior space of the arcades, a porch covered by a vault, so that areas not visible in the photographs may not be picked up, generating gaps in the polygonal mesh or may be recreated with a negligible quality.

It is therefore necessary to return to the site and capture new photographs in order to complete the information not represented.

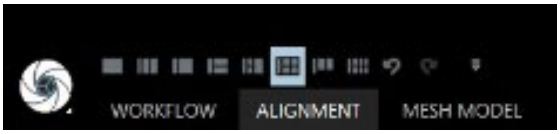
A good way to prevent some of these alterations is to generate a point cloud of *draf preview* model, made by a quick processing to obtain important visual information in a few minutes, it is a good tool to process in situ and not have to move later.

- **Final processing:**

After having taken the photographs, we created a new project with all of them, loading a total of 193 images into the program.

To help align the photographs, control points must be added by manually selecting them within each photograph, helping to join the components together.

To do this, start by selecting the section in the top bar and then divide the ALIGNMENT screen layout into 4 segments using the icon that mimics the result, found in the top bar in the left corner.



This action will divide the layout screen into 4 parts, then we select the screens one by one with the and assign to each of them a corresponding command, to assign to each of the screens a colour.

Screen 1: CTRL+1.

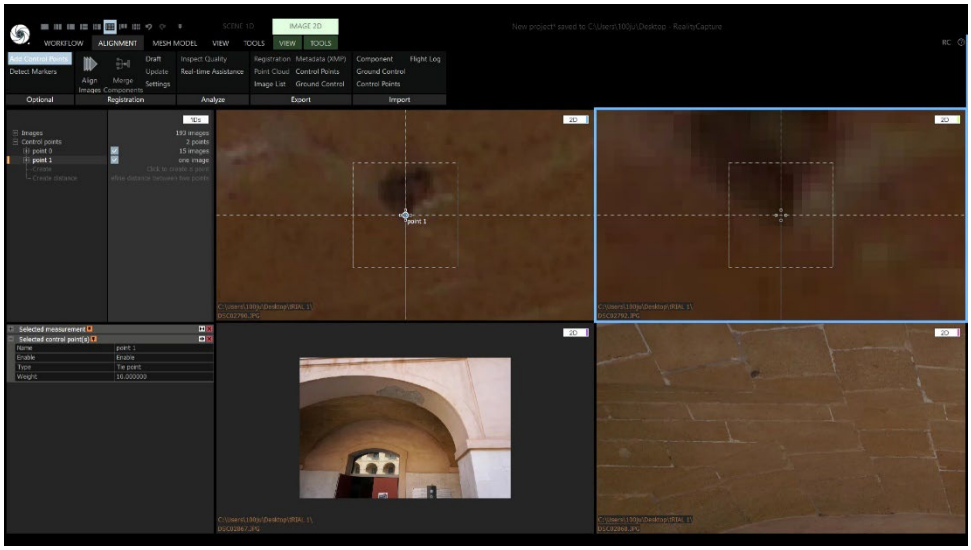
Screen 2: CTRL+2.

Screen 3: CTRL+3.

Screen 4: CTRL+4.

We proceed to drag from the *images* panel of the left table photographs to each of the 4 cells of the layput, being able to make a tour of all the photographs of the project, when we find a common element in numerous photographs click on it in each of the boxes, you can use the Zoom to have more precision, it is very important to perform this process accurately so it has to be an elementeo captured in several photographs easy to select and not rerpesente blurred. Once you select the element in the 4 images you can continue looking for the same element in the following images by dragging the next 4 images to each of the cells of the layout and repeating the process consecutively.

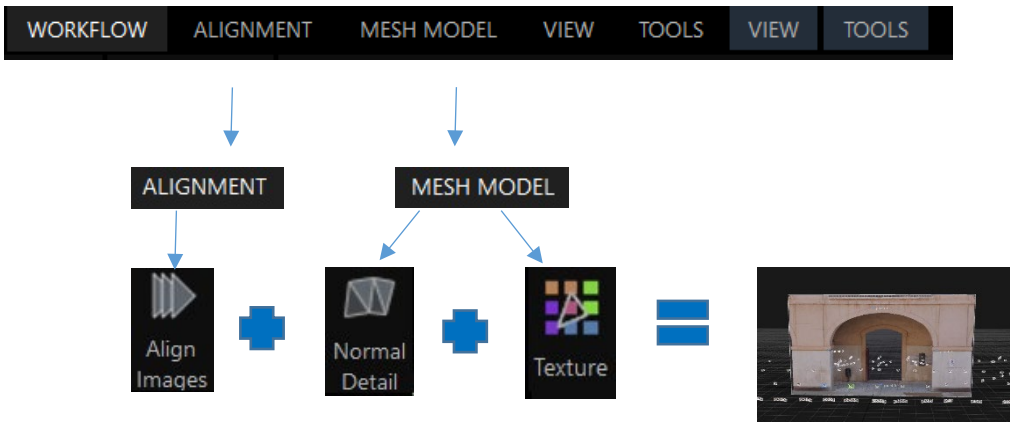
The greater the number of photographs that record a point, the more accurately it will be represented, likewise, the greater the number of points added, the more accurately the project will be aligned.



IMPORTANT, ONCE THE STITCHING PROCESS IS DONE, IT IS NECESSARY TO PERFORM THE PROCEDURE FROM ALIGNMENT.

SCHEME:

Once the control points are collected, we proceed to perform the same treatment of tools and in the same order as before, to obtain our 3D product.

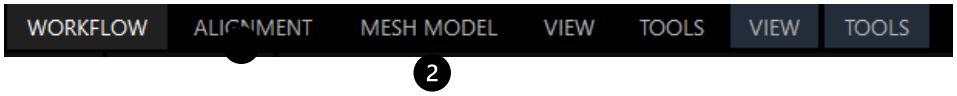


5.3- Practical Case 3:

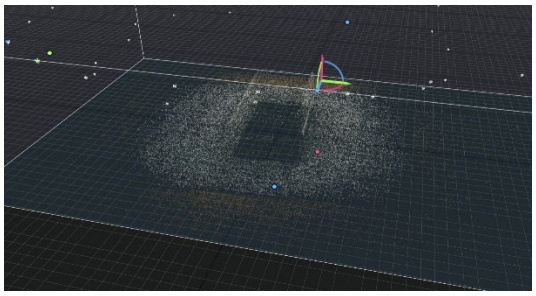
Object capture:

- **Data capture:** Object data capture is similar to that of space or a large surface, its principle is superimposition. The change of proportions makes that a movable or immovable object can be digitally documented thanks to its small size, so it is possible in most cases to obtain photographs from its 360, which is of great importance because it is possible to alternate paths around the object at different distances and with different angle of focus.

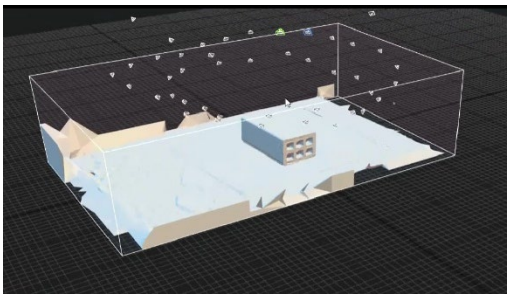
- **Processing:** To process the photographic data, the same actions must be performed by the program as in the previous example of space capture.



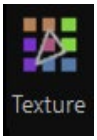
Starting with the "Image ALIGNMENT overlap" option in Settings, it is advisable to set the "Image overlap" option to "High" because an object, firstly due to its small size and secondly due to the number of photographs with high overlap, does not require the use of Control Points for its correct alignment.

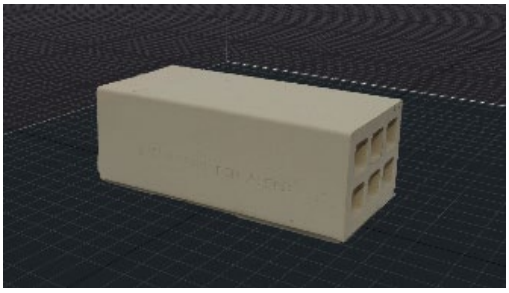


After obtaining the point cloud, we continue with the *mesh* processing, therefore, we access to the section MESH MODEL and select the *normal detail* option, if the alignment has been satisfactory, the reconstruction of the polygonal mesh does not require the settings to be retouched.

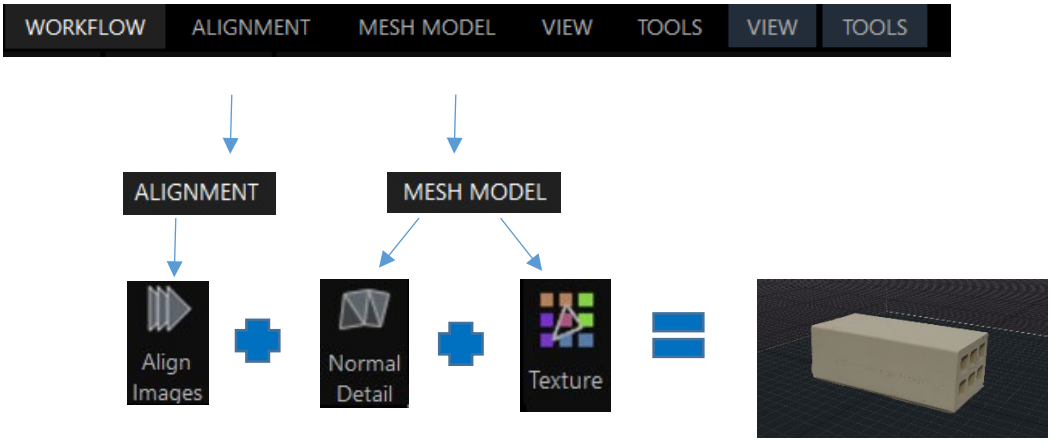


We observe if the reconstruction has been done in a satisfactory way, if it is the case we proceed then to cut the information of the excess mesh, that we don't need. And we proceed to texture the object by pressing the *Texture* tool, obtaining the final result of the processing.





SCHEME:



5.4- Video

https://www.youtube.com/watch?v=rHA60RLVQzc

6- Deliverables

In order for the teacher to be able to evaluate the students' use of the internship, the students will write a report of 3 pages maximum.

In this report, the student will explain the steps followed in the practice, the difficulties encountered and the decisions taken. The report will be illustrated with photographs of the data capture process and its processing, while the 3D file must be delivered in the same way and uploaded to the Sketchfab platform.

7- What we hace learned?

The realization of photogrammetric work in 3 case studies with its two stages, firstly, data capture with field work and then office work with data processing.

Field movements that the photogrammetrist must perform to photographically capture the item of interest.

Uses of the camera as a tool for terrestrial photogrammetry and the inclusion of the smartphone as a disruptive tool.

Image processing using the Reality capture program, editing it, obtaining a point cloud and polygonal mesh.

8 - File to use in the tutorial

Images in JPG format.

Project in RC (Reality Capture)

Dot cloud in the format...

Geometric model in OBJ format.