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

Title: Aerial 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 aerial form.

Show the adaptability of the technician and the use of different capture tools.

To show the collaboration of different photographic data, both terrestrial and aerial, and their harmonic union.

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 tutorial of high practical content will be carried out by capturing elements near or belonging to the training center, a heritage element, or a work in phase of structure, are sets of interest to perform this exercise. 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.

Drone equipped with camera if possible compatible with Pix4Dcapture, *you can check it in the following link:* https://www.pix4d.com/es/producto/pix4dcapture

SLR camera.

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- Hermitage Case Study

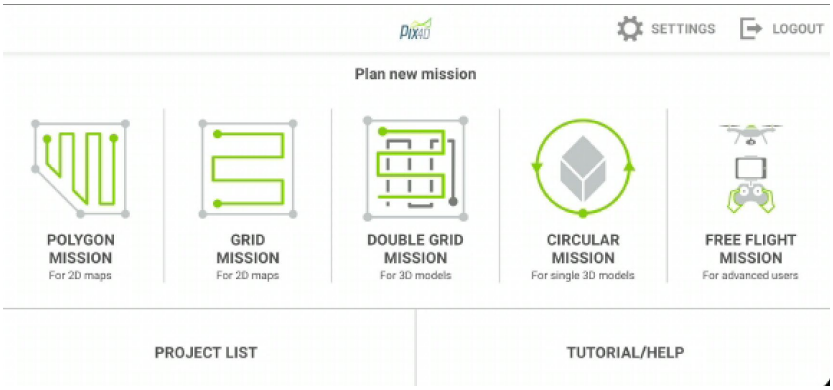
The data capture of a large element is based on the continuous photographic taking by superimposition from different distances and angles, in order to obtain information.

The use of drones greatly expands the value of the data documented by photographic capture because thanks to the drone is possible first of all to access places where the technician can not reach, can save heights and document elements with greater proximity as the cornices or overhangs present on the facades of buildings also capture another large series of elements were hidden to the eye such as roofs.

The height plays a relevant role not only when it comes to reach or access but also when it comes to photographic documentation in general, thanks to the height that a drone can reach can perform a three-dimensional mapping of the terrain documented physical relief of the environment or elevations, floors and roofs of the structures that are within the area of flight and capture.

Data capture: Data capture is done using drone for aerial shots and SLR camera for terrestrial shots.

Drone: The flight missions of the drone, are assisted by the Pix4Dcapture application, which allows us to establish a link between the mobile device connected to the controller and the drone.



For the realization of this exercise we have decided to make 2 flights over the captured building.

1- 

A Double Grid flight mission to document the entire roof and the environment in which it is located, with a 45º inclination to document relief elements, a mission carried out at a height of 30m.

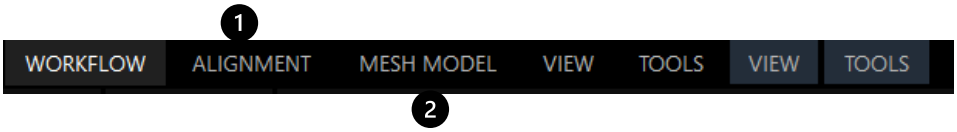
2- 

The second flight mission that is performed with the drone is the circular flight which is performed at a height of 20 meters; the circular path makes the axis on which the drone orbits the building itself so we can obtain photographic data in diagonal perspective obtaining data from both the roof and the elevations.

Camera: Photographs are taken with a reflex camera to obtain more information about the elevations, humidities, cracks and peeling of the elevations in order to better analyze the pathologies of the structure. Parallel tours to the elevations are carried out on 4 sides of the building, obtaining a total of 69 photographs.

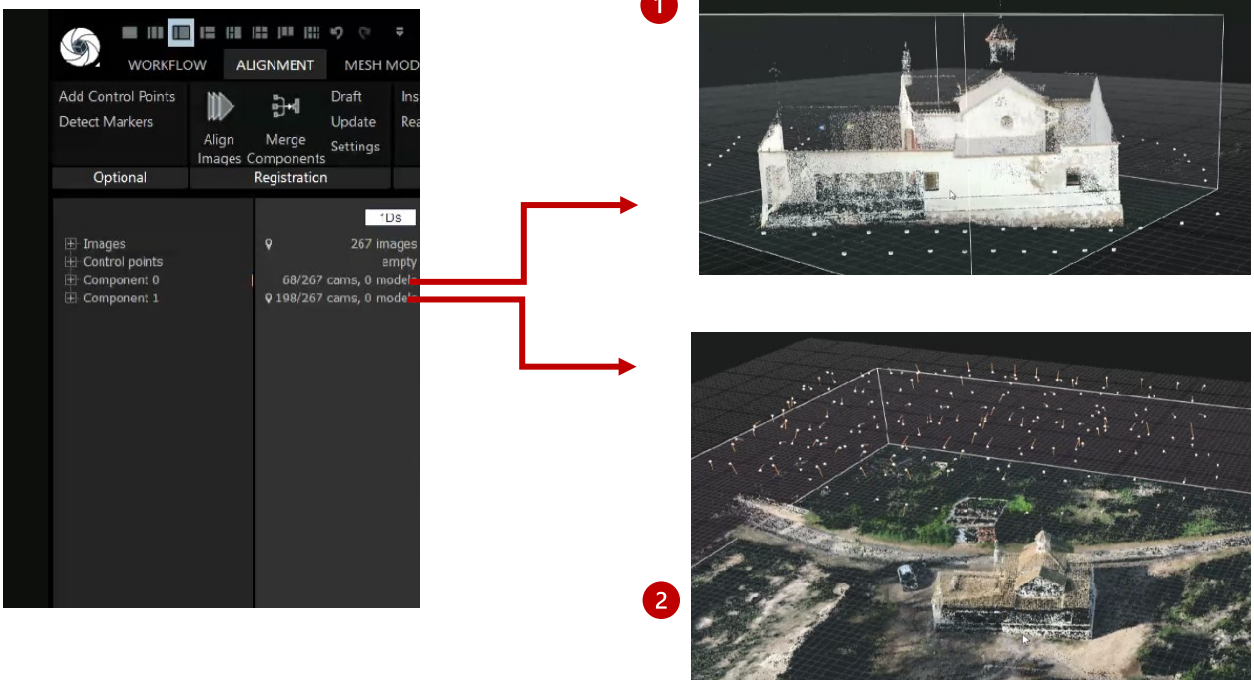
Software installation: The Reality Capture software is installed from its website https://www.capturingreality.com/DownloadNow It is necessary to register to use it, because although the information processing and editing is free, if you want to download the photogrammetric project, you must pay a small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

Reality Capture Processing: After the field shots, we proceed to the office or cabinet work for which we will have to manage in the photogrammetric processing exercise about 69 terrestrial photographs and 198 aerial photographs being in total about 267 photographs.



Beginning with the settings, it is advisable to set the *Image Overlap* to *Medium* or *High* if you have not taken a considerable number ALIGNMENT of photographs, due to the amount of data processed both aerial and terrestrial.

Once the parameters have been adjusted, we proceed to the orientation of the photographs and the search for the first search of homologous points in the form of a scattered point cloud by selecting the option 



After processing, we can see that the set of photographs has not been processed in the same "Component" but they have been divided into 2 components, this is due to the origin of the photographs. The program has divided and processed in 2 different components the terrestrial photographs and in another component the aerial photographs, so we obtain 2 different components formed by 2 different point clouds that correspond to the terrestrial session and the aerial session.

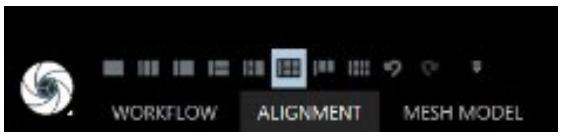
1. As we can see in the photographs above, in the terrestrial component only the elevations

can be seen without documenting the roofs or external information of the terrain or the surroundings.

2 On the other hand, in the second photograph we can see a view of the point cloud with data from the roofs of the building, elevations and the adjoining terrain; so we can see the interest of combining both photographic shots that complement each other perfectly.

So, to join both components we need control points taken manually, these control points will serve us to transmit the information to the program that the selected points in both aerial and terrestrial photographs are the same point or element, so when restarting the process once the points are obtained the program will synthesize the information and join both components into one.

To do this, start by selecting the section in the top bar and then divide the screen ALIGNMENT 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 layout, 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 element captured in several photographs easy to select and not represented in a blurry way. 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.

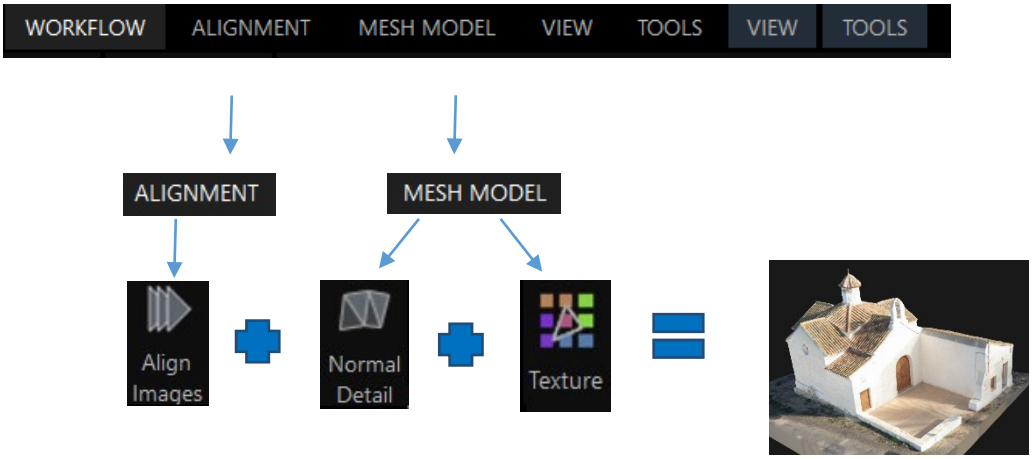
The greater the number of photographs that record a point, the more accurately it will be represented, likewise, the greater the number of points added, the more accurately the project will be aligned.

Once the points have been documented in both aerial and terrestrial photographs, repeat the alignment process and click on the button:

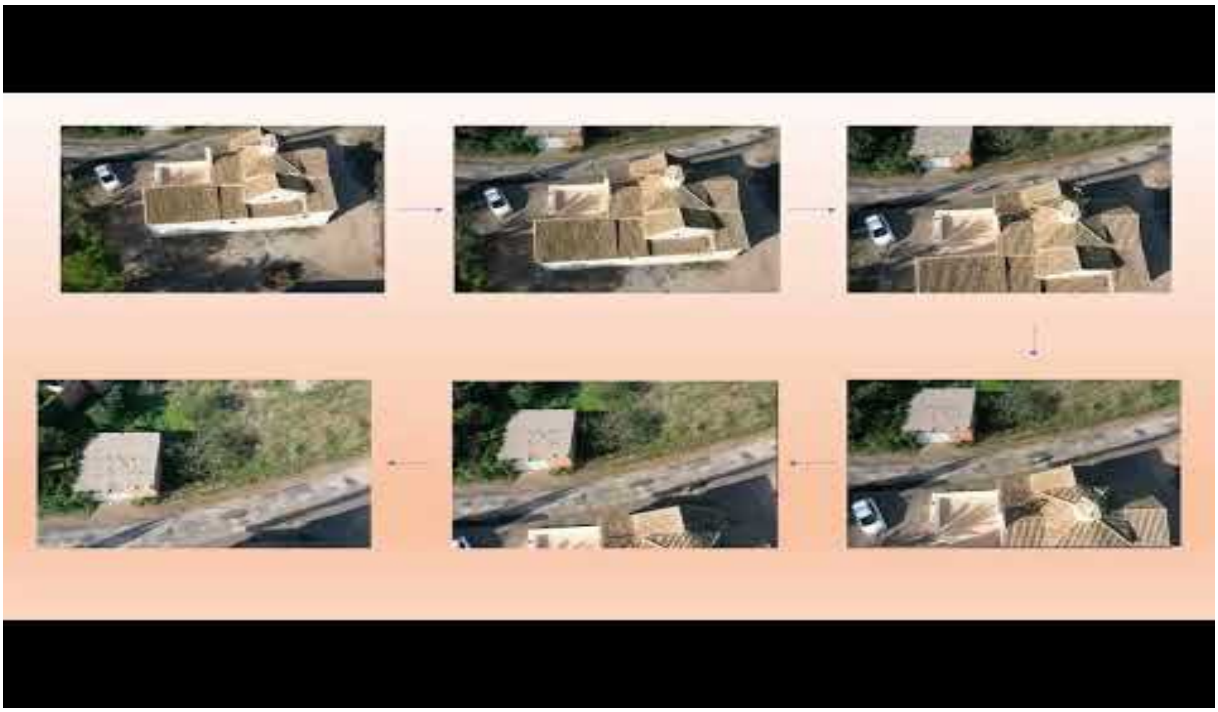
After obtaining the point cloud, we continue with the *mesh* processing, therefore, we access to the section and select the MESH MODEL *normal detail* option, if the alignment has been

satisfactory, the reconstruction of the polygonal mesh does not require the settings to be retouched.

SCHEME



5.2- Video



https://www.youtube.com/watch?v=Uqvfgf2zetA

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 have learned?

The realization of photogrammetric work by drone, in its flight stages and different missions in addition to smartphone applications for handling and subsequent office work of data processing.

The importance of fixing height, speed, camera angle and overlap to the characteristics of the element to be photographed.

The interpolation of aerial and terrestrial photogrammetry in the data capture of the same project.

The collection of geo-referenced data using drone photography.

The processing of images obtained by 2 different mechanisms such as a reflex camera and a drone, the combination of these data in the same geometric model georeferenced.

8 - Files to use in the tutorial

Images in JPG format.

Project in RC (Reality Capture)

Geometric model in OBJ format.