ENV-408 Ex01: Image measurements, coordinates and distorsion model

Objectives

> 1. Learn how to do manual measurements on an image and get used to common image coordinate systems.

> 2. Understand what a distorsion model is and what impact it has on measurement coordinates.

Methodology:

- Given an image with indicated objects (see the close-up screenshots), perform *manual measurements of their image coordinates* by clicking on the centers of objects using a professional photogrammetric software.
- Convert the obtained coordinates from the *top-left* image coordinate system to the *perspective-centered* image coordinates.
- Once those *N* points are measured, implement a *Contrady-Brown* distorsion model (with a given set of parameters) and use it to undistort the measurements (via a *solver*).
- Finally, *visualize the impact of the distorsion model* at image level by undistorting a grid of pixels covering the entire image. *Test different values of distortion coefficients* to understand their impact on the image coordinates.

Input data

The following folder is provided on moodle (click button "**Download folder**"):

```
main
|   Lab01.ipynb
|   Lab01.py
|   Lab01.pdf
|
└─── raw_data
|    |   1092311568.jpg
|    |   1092311568_marked.jpg
|    |   1092311568_assessement.jpg
|    |
|    └─── GCPs_1092311568
|         |   GCPs_100_1092311568.jpg
|         |   ...
|
└─── measurements
```

Setup

This section explains how to setup your Python environment for excercises 1, 3 and 4.

We recommend using an Anaconda/Miniconda virtual environment as support for these exercises. Alternatively, you can use the Noto service to run jupyter notebooks directly on EPFL servers, without installing anything on your machine (only valid for lab 01)

Anaconda/Miniconda

Intallation instructions are avaialble here.

Create a new environment with the following commands or via the graphical interface and install required packages:

1. Create a new environment (needed only 1st time or if deleted):

```
$ conda create --name SM4EO python=3.9
```

2. Activate the environment (needed only 1st time or if another environment is active):

```
$ conda activate SM4EO
```

3. Install dependencies:

```
$ pip install numpy scipy notebook opencv-python pandas matplotlib scikit-learn
```

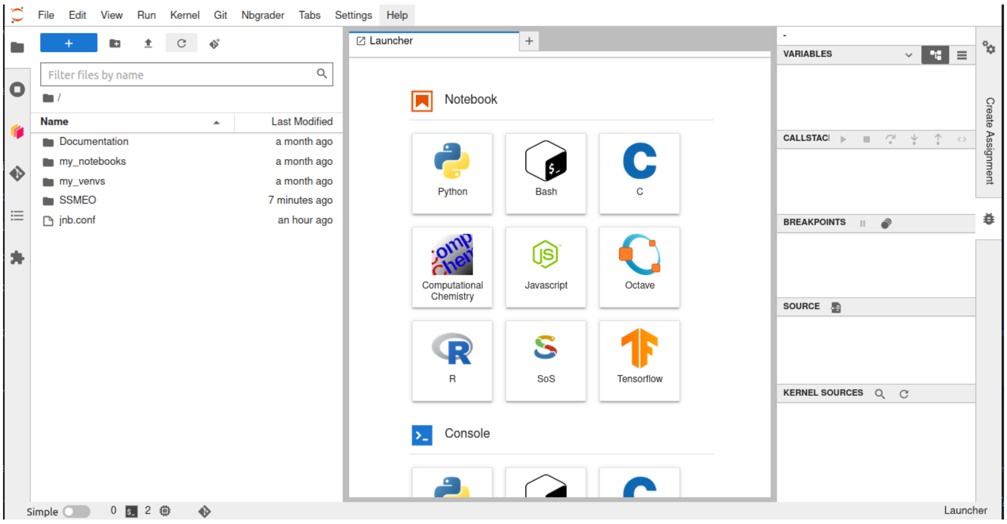
4. Change to the directory of the excercise and run jupyter notebook:

```
$ jupyter notebook
```

Once the notebook in running in a browser, open the file `Lab01_Excercise02.ipynb`. You can run the first cell (`Shift+Enter`) of the notebook to verify that your environment is set up for the exercises.

Noto

Connect with your GASPAR Credentials at Noto. This will open the page below:



On the left pane, you can manage folders and files. Since Noto does not allow to drag and drop a folder, you will have to upload required files manually.

To do so, you can create folder (right click -> New Folder) and upload files by dragging and dropping them from your own file explorer.
Upload the following files from the Lab01 folder :

- Lab01_Exercise02.ipynb
- raw_data/1092311568.jpg
- raw_data/1092311568_marked.jpg
- raw_data/1092311568_assessment.jpg
- raw_data/cam_param.txt
- XML file that will be generated in exercise 01

Note that the folder names should match those provided by the Lab01 folder from moodle as the paths have been defined accordingly in the notebook.

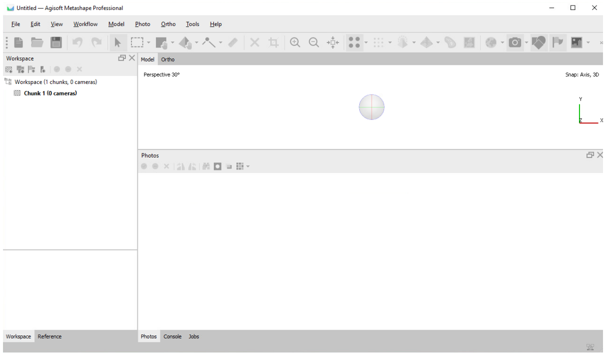
Once files are uploaded, you can open the notebook by double clicking on it an run the first cell by pressing `Shift+Enter` to check that imports are done properly.

Part 1 : Introduction to Agisoft, manual measurement on images

Agisoft Metashape is a professional photogrammetric software. You can access it on EPFL VDI machines accessible here with your gaspar credentials.

> Note: To run the VDI in a browser choose `VMware Horizon HTML Access`, alternatively download and install the VMware Horizon Client and connect to `https://vdi.epfl.ch/portal/webclient/index.html`

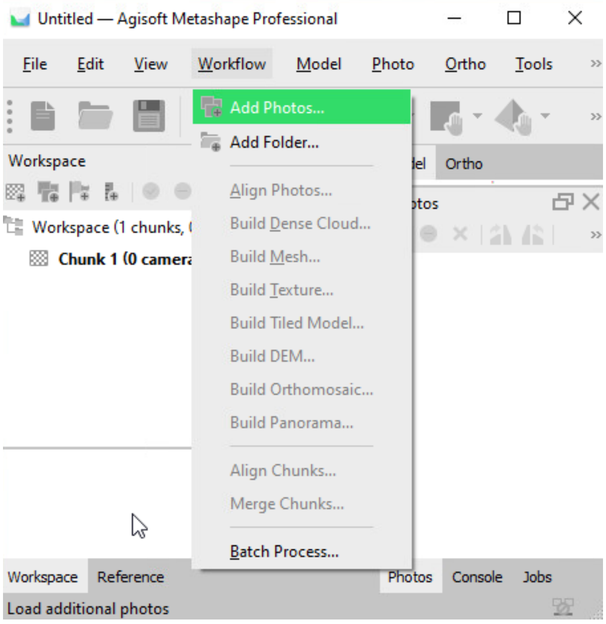
Access a vdi machine on the ENAC-SSIE-WIN pool and launch Agisoft from the Applications folder on your Desktop `Applications\APP-SSIE-TOPO\Agisoft Metashape Professional`. Agisoft main page will open



1.1 Load images :

> Note: For executing this step you may want to first copy the image `raw_data/1092311568_marked.jpg` to a personal network folder, to which the VDI machine has access.

To import images into your project, go to the `Workflow` tab, `Import photos`.



Import the photo `raw_data/1092311568_marked.jpg` into your project.
Once imported, you should see one image in your so called "chunk". The image can be displayed by double clinking its name or thumbnail.

1.2 Create markers :

You can see that 12 control points have been approximately marked on the image.
We need to extract accurately the coordinates (in pixels) of those control points. For each of the 12 points, in the `raw_data/GCPs_1092311568/GCP_"X"_1092311568.jpg`, you will find close range screshots over each GCP to help you accurately pin the point on the image.

Accurately create a pin a marker for each control point in the image. To do so :

1. Right click on the selected pixel and select `Add marker`.
2. Refine the position of the marker if needed with by holding left click
3. Rename the marker with the corresponding control point id : Under `Chunk -> Marker` , right click on your marker and rename it.

> Note: An accuracy of pointing +/- 3 pixels (equivalent to 30 cm on the ground) is tolerable for the latter labs.

1.3 Export markers

To export the image coordinates of the markers, go to `File -> Export -> Export Markers` and save your markers as an Agisoft xml file.

Save these measurements to the `measurements` folder, they will be needed for exercise 02.

Part 2 :

In this exercise, you will learn how to correct lens distorsions on image measurements:

> Code skeleton to complete is provided in *Lab01_Exercise2.ipynb*

> For non-jupyter user, the used functions and function declarations are provided in a *Lab01_Exercise2.py file*.