Underwater system unit

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ifremer

Matisse 3D Quick Start Guide

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1. Introduction

This document is a quick start guide to help you to process a complete dataset with Matisse, mainly oriented toward 3D reconstruction. It treats about pre-processing and processing.

The first step is the pre-processing of the dataset. This step is mandatory when using video dataset, as it converts video to images and recommended for images only. The pre-processing tool allows to reduce resolution (for faster reconstruction), and to color correct images.

The second and last step is the selection of a reconstruction algorithm and launching of the reconstruction.

2. Installation of Matisse 3D

This is the easiest step. Just launch matisse-setup.exe and follow the instructions.

3. Pre-processing the dataset

Once Matisse is installed, the pre-processing tool can be launched from the start menu ("MatissePreprocessing") or from Matisse (Tools->Launch preprocessing tool). The preprocessing tool comes as a wizard with the following first page (Fig. 1):

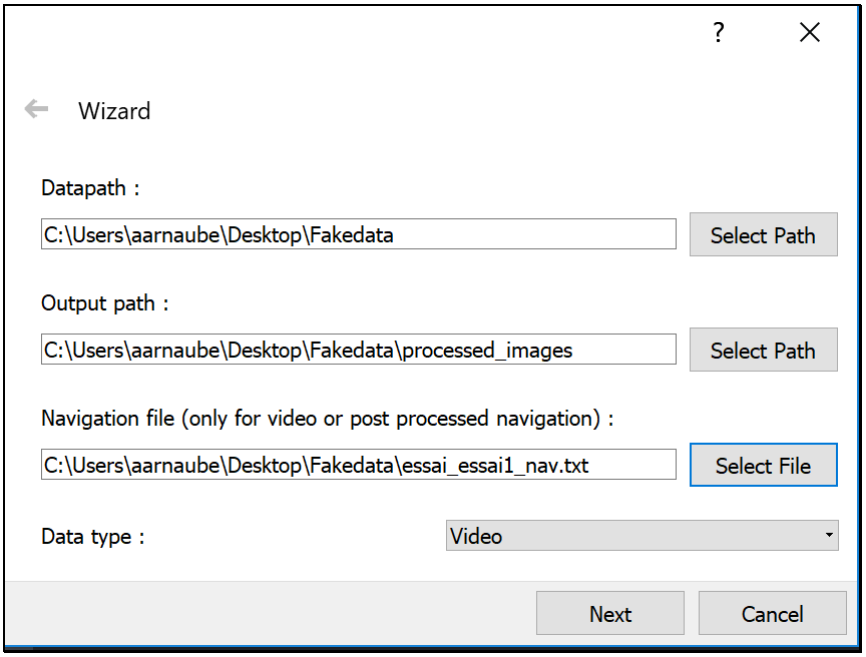


Fig 1. First preprocessing wizard page

In the first page you must enter the datapath with "Select path" and select the folder containing video(s) or images to be processed. Be careful: if you want to synchronize video with navigation (which is a major point if you want a scaled reconstruction) the video must have its name corresponding to its starting date and time.

Two file formats are supported:

- Ifremer historical format: missionname_divenumber_YYMMDDHHmmSS_CAMID.ext (Where missionname, divenumber are what you want but must be present, YY is year with 2 digits, MM is

month, DD is day, HH is hour, mm is minutes, SS is seconds and CAMID is a number identifying the camera channel, and ext can be almost any video extension).

- Second is ISO Time naming: YYYYMMDDTHHMMSS.FFFZ.ext following the same convention as before but with FFF representing milliseconds.

Same kind of constraints applies to images: if you want to synchronize images with the navigation the photo must have its name corresponding to its date and time of shoot with the following format: YYYYMMDDTHHMMSS.FFFZ.ext (where ext can be jpeg, jpg, tiff, png)

Then output path is automatically filled to datapath\processed_images but can be changed as you like.

Finally, you can select a navigation file (again if you need navigation synchronization) and select the data type (video or photos). See appendix C for the supported navigation format.

Once you press “Next”, you arrive on the second wizard page (see Fig. 2):

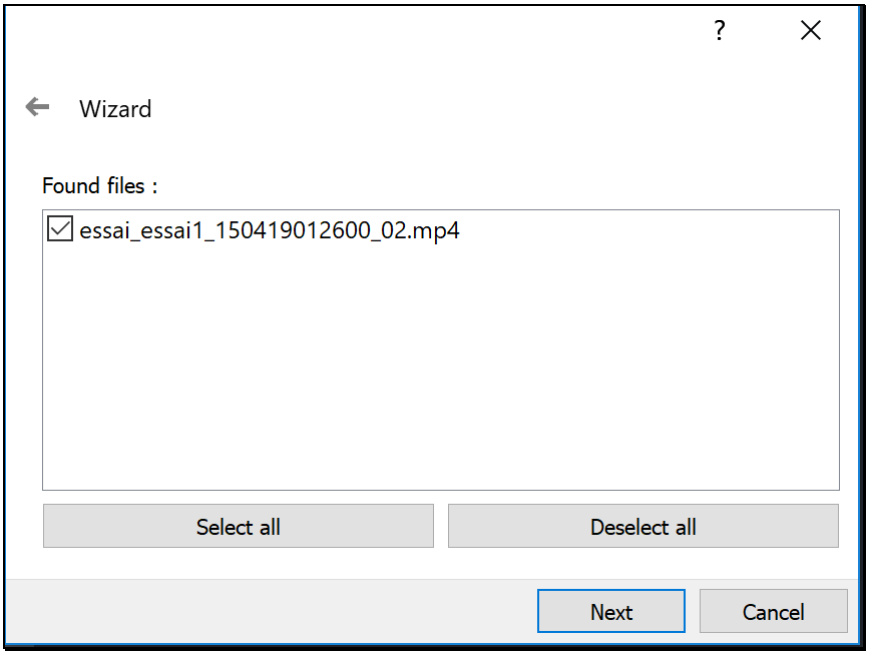


Fig. 2 Selection of files to be processed

You can see a list of the supported files that has been found. You can select a subsample of the files you want to process.

Then clicking “Next” again you arrive to the last page (see Fig. 3):

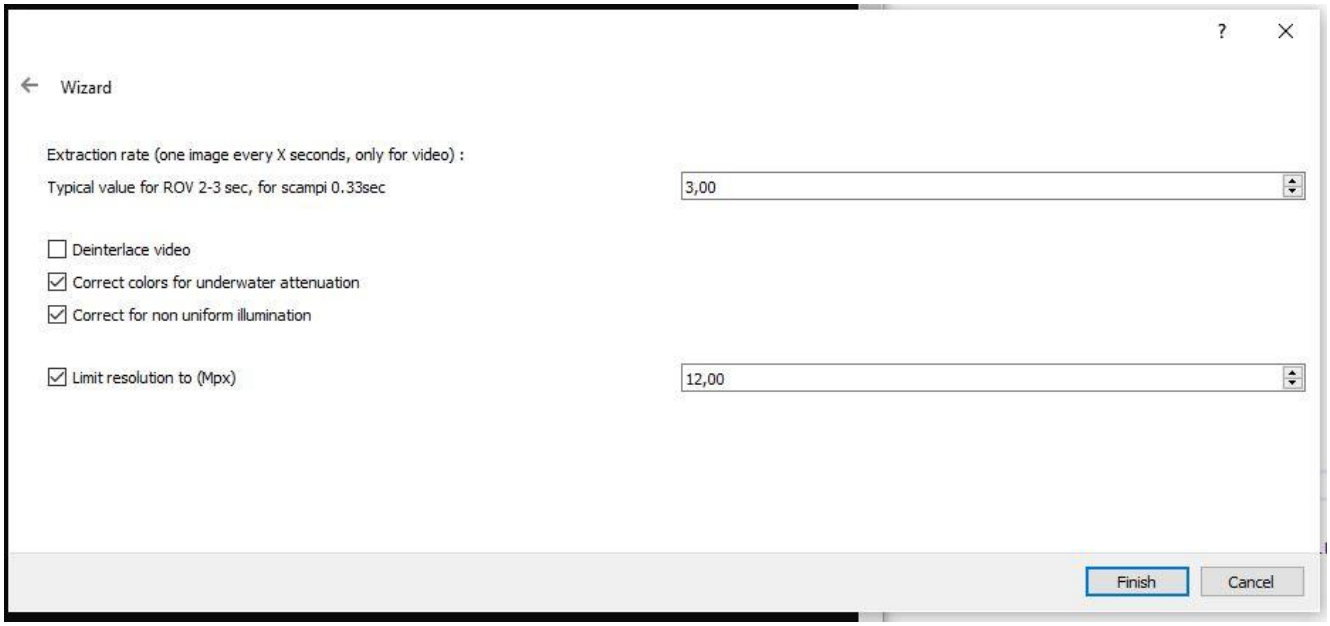


Fig. 3 selection of preprocessing parameters

In this page, you can select the processing parameters. There are 4 parameters:

- Extraction rate: This parameter is only used for video and represent the time left between two images extracted from the video. The more the camera moves quickly, the shorter this time should be. A typical value is 2-3 seconds for ROVs and Nautile and 0.33 seconds for faster vehicles (like ifremer’s scampi).

- Deinterlace video: This parameter is only used for video. Must be checked if the input video is interlaced (eg. Scampi HD or old Victor HD format)

- Correct colors: Check this case if you want to correct images for colors, meaning removing underwater colors artefacts.

- Correct for non-uniform illumination: Check this case is your input image have a non-uniform illumination pattern (like a lot of light at the center and decreasing toward the edges).

- Limit resolution (in Mpx): This option is very useful if you don’t want to spend a month on the same reconstruction. If the resolution of images is higher than this value, then images are scaled down to this value.

Finally click on finish button and the dataset is preprocessed.

4. Post-Processing with Matisse

To build reconstruction from your images you can run Matisse 3D in post-processing mode (this is the default launching mode, see appendix A for other available modes). You should have a purple/gray windows like this one (Fig. 4):

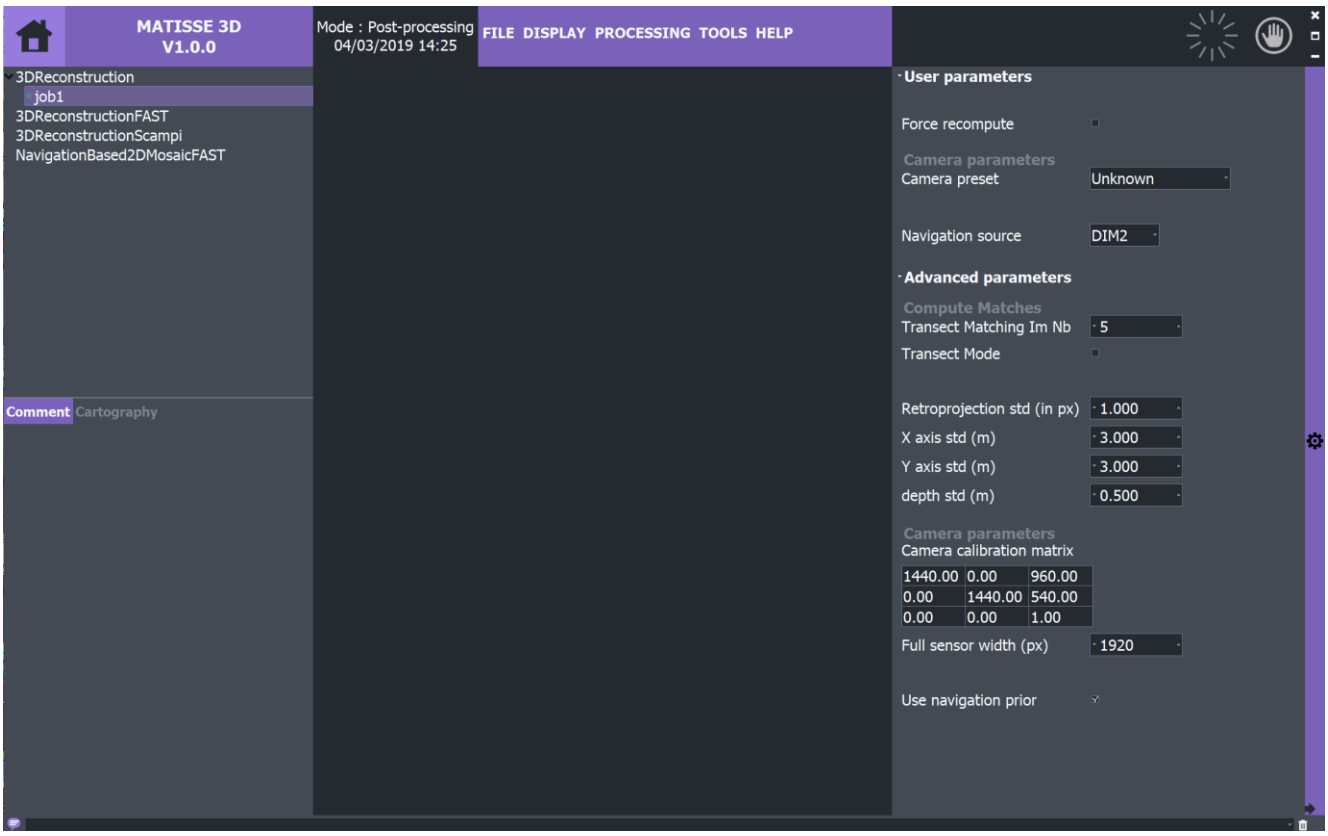


Fig. 4 Matisse post processing interface.

The left panel lists the available processing, the main menu is at the top, with a wheel to tell it's processing and a hand to stop the current process. The right panel is for tuning algorithm parameters. Parameters are classified in to categories: user (very easy to understand) and advanced (deeper lever of comprehension but not expert).

First action is to select the right algorithm for your purpose. The choice is quite easy, here is a description of the algorithms:

- 3D Dense: This is the most generic algorithm for 3D reconstruction. You can use with images acquired with an underwater vehicle or a diver.
- 3D Dense FASTER: Same as the previous one but faster. Useful for low capacity computer but the result resolution can be a bit lower than 3D Dense.
- 3D Sparse FASTEST: This is the fastest technique but provide the less 3D details about the scene. Can be used for low power computer or when overlap between images is too low or just to simply have a result as fast as possible.

To apply an algorithm to your dataset you must right click on the algorithm of your choice (left panel) then click “create new task”. This will open the following window:

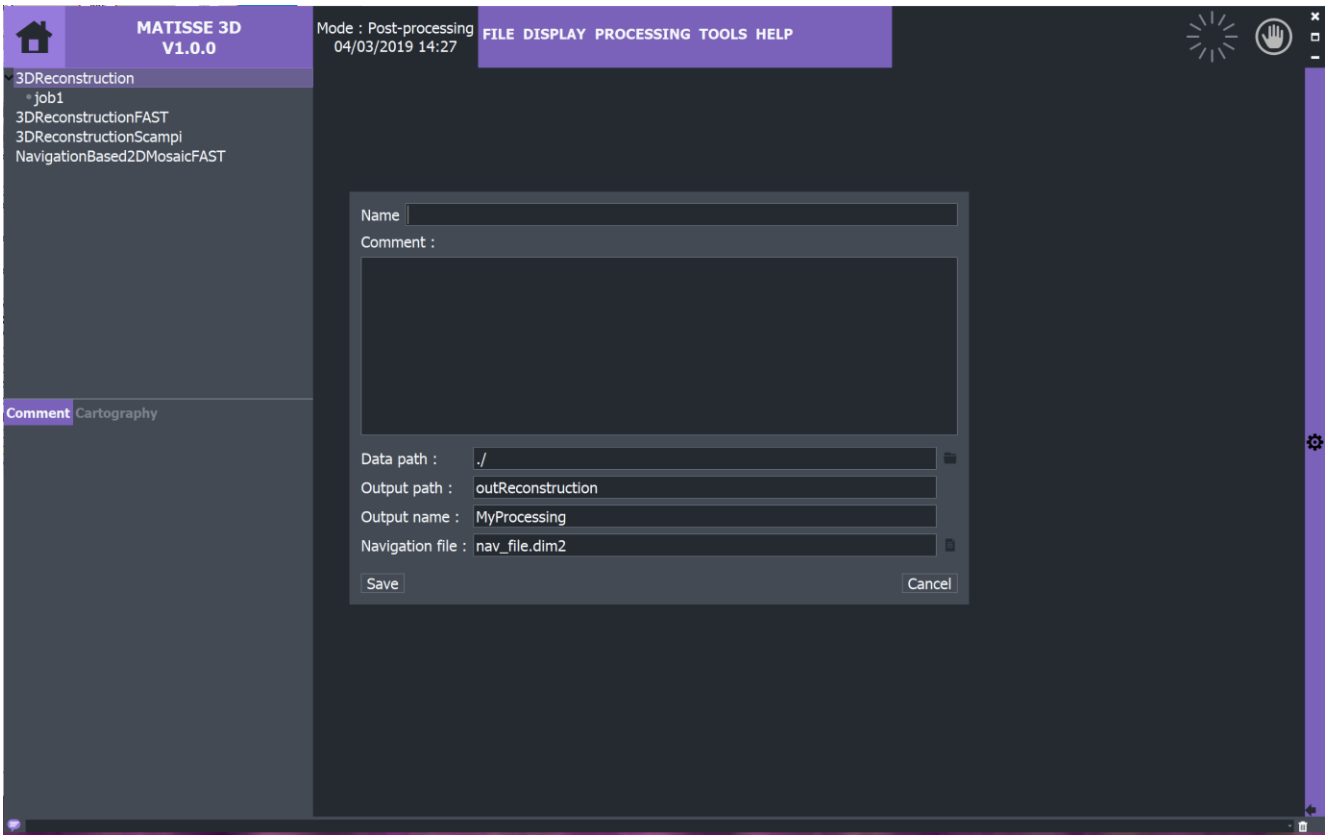


Fig. 5 Required information to start processing.

You have to give a name to your task. You can optionally enter a comment. You must also select data path (where data is located). You can leave the default output folder which is “outReconstruction”. You can select a name for the reconstruction (this is the name that will be given to 3D files). And finally you select the navigation file (if you have one, which is mandatory if you want scaled reconstruction) and click on “Save”.

The task (we also call it job) appears under the algorithm name on the left panel. The right panel opens and gives you the opportunity to tune some parameters for the acquisition. The main ones are:

- Camera preset: select the camera you used for the acquisition. If you don’t know the camera you can select “unknown” but result quality can be a lot lower. The default available cameras are the ones from Ifremer vehicle but you can have a look at appendix B on how to add your own cameras.
- Navigation source: Use dim2 navigation file or EXIF. If EXIF is selected, the standard GPS data is used from image metadata.
- Navigation and image quality parameters (they can differ for USBL only vs PHINS):
    - Reprojection std (in px), this is the confidence of point localization in camera frame
    - X axis std, standard deviation in navigation x axis.
    - Y axis std, same as X for Y
    - Depth std, same as X for depth

Then you can right click on the task to save parameter with “Save” button. Then right click again to run it with the “Run button”.

As long as the wheel is turning, it means that the program is not crashed. It can take very long time to process a big dataset, not meaning that the software is frozen. For example, with a 2018 gen core i7, 4000 thousand images in HD resolution can take around 1 week to process.

5. Description of the output files of the reconstruction

There could be multiple destination folders if it were not possible for the algorithm to join all images in a single model. Multiple files will be found in each destination folder. Here is an example of files you will find if the reconstruction is called “MyProcess”:

- Result files:
  - **cloud_and_poses.ply** -> 3D sparse reconstruction, first step of the reconstruction
  - **MyProcess_X_dense.ply** -> same as the previous one but with more points (densification)
  - **MyProcess_X_dense_mesh.ply** -> meshing (surface) made with the previous one
  - Final reconstruction files (with texture reconstruction). You need all those files for further treatments:
    - **MyProcess_X_texrecon.kml**: geo-localization file
    - **MyProcess_X_texrecon.obj**: 3D data of the model
    - **MyProcess_X_texrecon.mtl**: list of textures
    - **MyProcess_X_texrecon_materialYYYY_map_Kd.png**: images for texturing

- Temporary files that can be removed if you’re satisfied with the result:
  - All mvs files
  - Files beginning with xxxx_Resection.ply (where xxxx is a number)
  - spt and vec files
  - MVE folder
  - “Matched” and “splitted_matches” folders

Appendix A : Application modes

Matisse can be run in different modes for different purposes. You can change the current mode by clicking on the house icon in the top left. You see the following window:

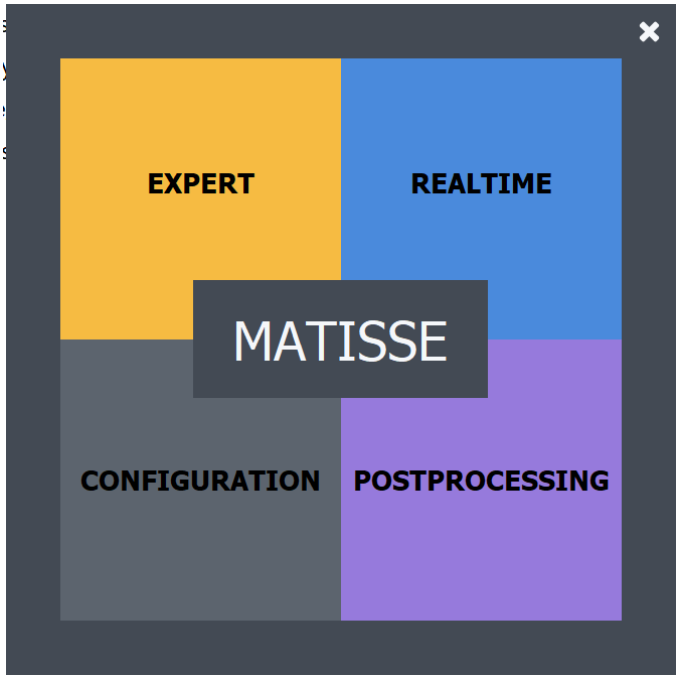


Fig. 6 Matisse welcome dialog. Let you choose the running mode

There are three launching modes:

Expert mode, corresponding to yellow top left square in figure 6, which, as the name suggest, is mainly for expert, giving access to all Matisse settings and processing chains creation. This mode is grayed by default and can be activated in configuration (bottom left). You should not need to go there but the technical support can ask you to go into this mode mainly for helping solving your particular case.

Realtime mode for realtime image processing. This mode is not used at the moment as no realtime algorithm has been released.

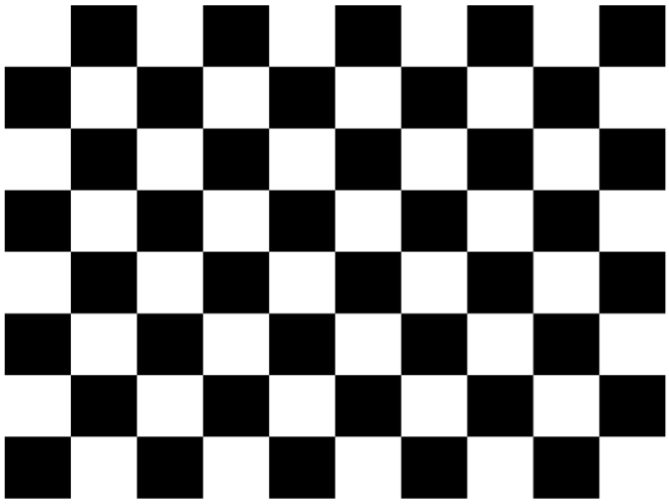
Postprocessing mode, which is the main user mode for launching reconstructions on already acquired data. This quick guide will treat about this one.

Appendix B : Camera calibration and management

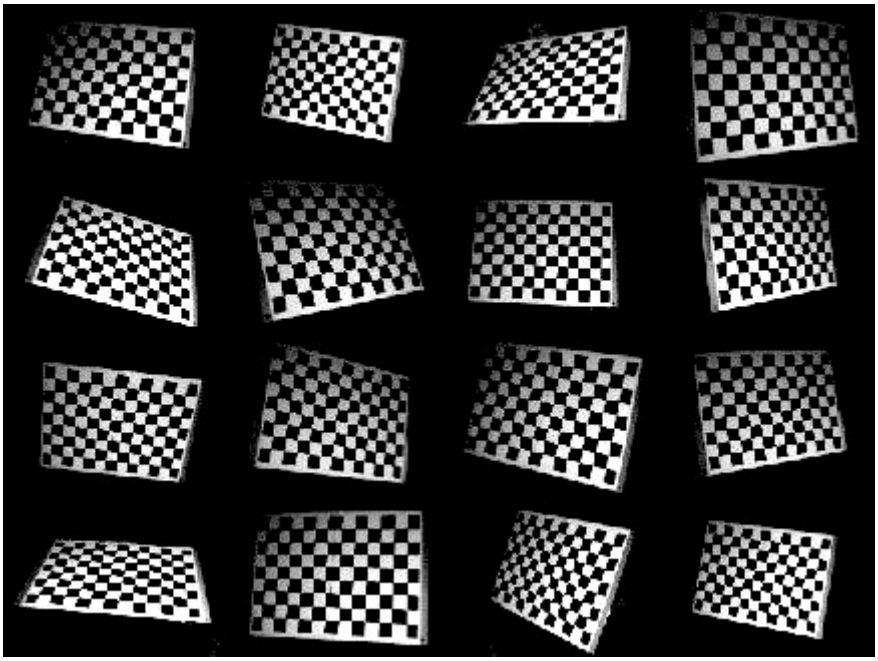
In order to obtain the best possible results for your reconstructions it is highly recommended to calibrate your cameras. If your camera has a zoom, you must calibrate it at the same level of zoom as the one used for the reconstruction. If you camera is used for underwater images, then you must calibrate it with images taken underwater. It is recommended to calibrate your camera at full resolution and Matisse will handle any rescaling. If you already have a calibrated camera you can directly add it using matisse camera manager.

A. How to calibrate your camera

For the calibration you will need a chessboard calibration pattern like this one:



This calibration pattern is a is a 9 by 7 chessboard pattern. You will find plenty of calibration model on the web that you can print. It is of major importance that you leave a white space around this pattern, otherwise it won't be detected by the software. Then you must acquire multiple images of this pattern in different position like those 16 images:



The pattern should not be to far from the camera, fit entirely in the camera field (not cropped at the corners) and you should vary the angles from one image to the other. At least 10 images are recommended, but the more you take the better. If you have any doubt you can contact the authors of the software.

Once you have the calibration image you can launch Matisse camera calibration tools from the main menu (Tools->Launch camera calibration tool). You should have a window similar to Figure 7, in which you have to enter the required parameters.

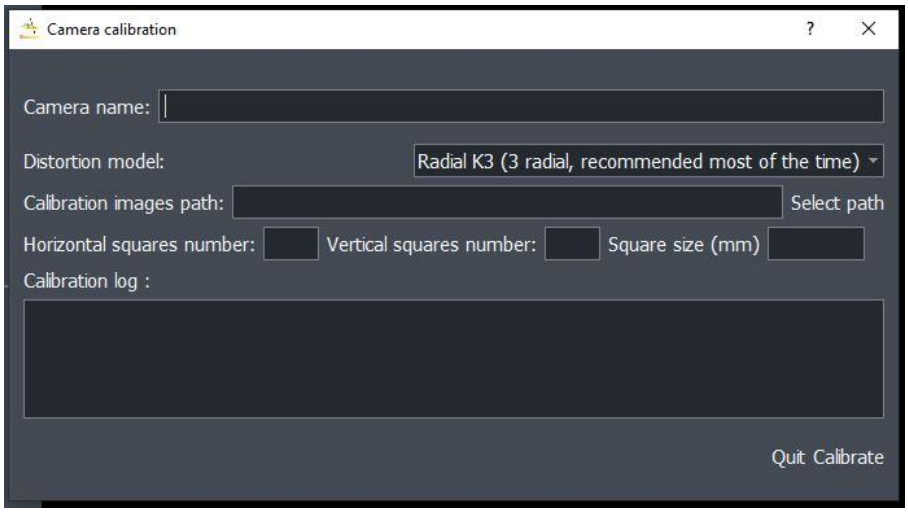


Fig. 7 Calibration window

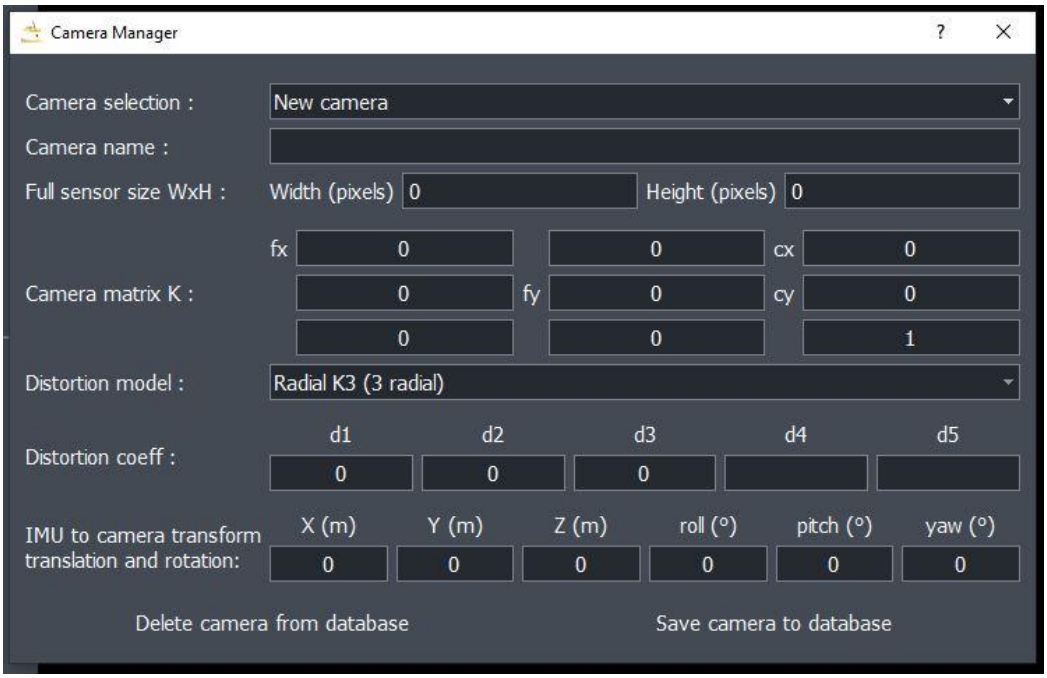
Here is a description of the parameters you have to enter:

- Camera name: This is the name you camera will have in Matisse after calibration
- Distortion model: Most cameras will give good results with Radial K3. If you have a fisheye camera then it is most of the time better to use the fisheye model. In any case you can try multiple models and retain the one with the lower calibration error. If Radial K3 and Brown T2 gives the same error then you should use Radial K3 as it is a simpler model and it will hence improve the stability of the reconstruction.
- Calibration images path: Select path to your images.
- Horizontal squares number: number of horizontal squares in your pattern.
- Vertical squares number: number of vertical squares in your pattern.
- Square size: size of square edge in your pattern.

Once all the needed information has been entered you can click on Calibrate to start the calibration. At the end of the process if everything goes well, your camera will be added to Matisse camera and available for processing.

B. Camera manager: Add/Remove/Check the available cameras in Matisse

You can launch the camera manager from Tools->Launch camera manager. The opened window is as follow:



You will find in the camera selection list all the camera calibrated with Matisse or added through this manager. You can modify one and save it or you can create a new one by selecting “New camera”. All the parameter are classical camera parameters, called intrinsics. The last line is the position of the camera, relative to the center of navigation. If the navigation you use is outputted at the camera location or you don’t know, then you should leave all equals to 0.

Appendix C: Supported navigation format

The recommended navigation format is as follow. It is a csv file (text file) with one header line. The following lines are like this :

yyyy/MM/dd, hh:mm:ss.zzz, lat, lon, depth, alt, yaw, pitch, roll

where yyyy is 4 figure year, MM is month, dd is day, hh is hour, mm is minutes, ss.zzz is decimal seconds with 3 floating values, lat is latitude in decimal degrees (must have high accuracy), lon is longitude in decimal degrees (must have high accuracy), depth is positive underwater and negative above (opposite of altitude in airborne application), alt is positive distance to the see floor. Yaw, pitch, roll are the attitude angles in degrees. The mandatory fields are the 5 first ones for 3D and the first 6 ones for 2D. If you don't have the information for the others you can leave them equal to zero. If you plan on regularly use Matisse and you want your custom navigation format to be included, you can ask the authors to add it.