The grid

Method for a precise location of the entrance pupil on a DSLR(*) camera

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The technical progress in the domain of panoramic photography along with the expansion of broadband Internet connections have allowed for a considerable rise in the quality of panoramas and their full screen presentation.

This is my method to locate the entrance pupil with precision ... a simple grid !

The flipside of this breakthrough is that any imperfection becomes much more noticeable and demands tedious retouching prior to publication.
In order to near perfection, starting from the shooting time, it is crucial to match the entrance pupil of the lens *(also inaccurately referred to as "nodal point")* with the 2 axis of the spherical panorama head *(left-right rotation and up-down tilt)*. This ensures a perfect stitch of the pictures by getting rid of parallax errors for good.

How to precisely locate the entrance pupil ?

For the beginner panoramist, this quest often resembles that of the Holy Grail... everybody is talking about it but its precise location remains hard to find.

Different methods, some more or less complicated, allow achieving decent results for most cylindrical panoramas. The difficulty increases, as multiple rows of images need to be stitched in order to achieve cubic or spherical panoramas. Often one believes to have spotted the darn entrance pupil, then as it happens that they shoot a pano with a nearby foreground, problems are revealed and perfect stitching becomes impossible.

Here is the method I use. It will help you locate the entrance pupil on any reflex digital camera, whatever lens or add-ons it is mounted with.
Simple and error free, it also allows fine-tuning of settings by eliminating slight horizontal and vertical shifts.

*(*) If you use a **non reflex** camera, it is definitely possible to follow the method as described. Check your step by step results in your favourite image editor (Adobe Photoshop, ...).*

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The required hardware

- A digital reflex camera mounted on a tripod with a spherical panoramic head.

  For this demonstration, the following hardware was used :

  - A Minolta Dîmage 7Hi *(28-200)*
  - A Manfrotto *(Bogen in the US)* tripod
  - A Manfrotto QTVR Kit (head)
  - A Kaidan QuickPan spherical arm
- a stiff grid as fine as possible. Here a stand for kitchen utensils is used. ;-)
- a piece of rope to suspend the grid
- a courtyard with 2 nearby walls (*or posts*) to tie the rope onto
- no wind *(grid stability)* !
- a little patience !

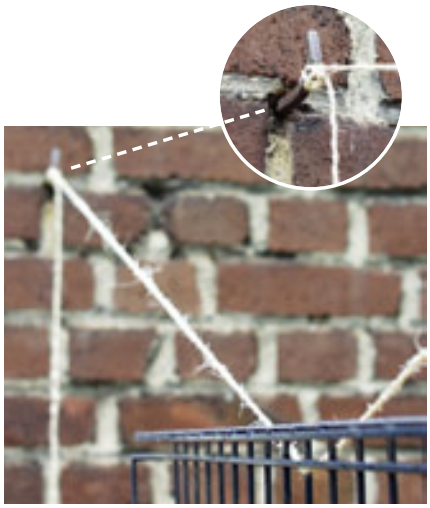
You now have all the ingredients, let's move on to the recipe !

The hardware is set up in front of the grid.

The installation

Run the rope into the top meshes of the grid and tie the ends to the walls *(or posts)* so that the center of the grid hangs approximately at eye level.

The weight of the grid strengthens the setup and allows near vertical self-stabilisation if there is no wind ! ;-)



Fasten the camera on the tripod with the spherical bracket, and place the whole setup as close as possible to the grid, leaving just enough free space to allow rotating the camera without hitting the grid.

Tip ! If you wish to centre the grid with the lens *(it will look nicer !)* all you need to do is slide it on the rope to bring its centre in front of the lens. Then level the tripod height to match its centre.

Remark : *it is not necessary that the grid be parallel to the camera or the ground. But as soon they are both installed, the grid and tripod should not move at all during fine-tuning.*

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Step 1. Basic adjustment

For a good adjustment, the horizontal rotation must be centred on a vertical virtual axis running through the entrance pupil.

Start by positioning your camera so that the centre of the lens *(as seen from the front)* is as precisely as possible at the vertical of the rotating axis of the spherical bracket.

This basic preliminary adjustment can be measured by eyesight, or better with a plumb line.

The centre of the lens and the rotating axis are on a same vertical line.

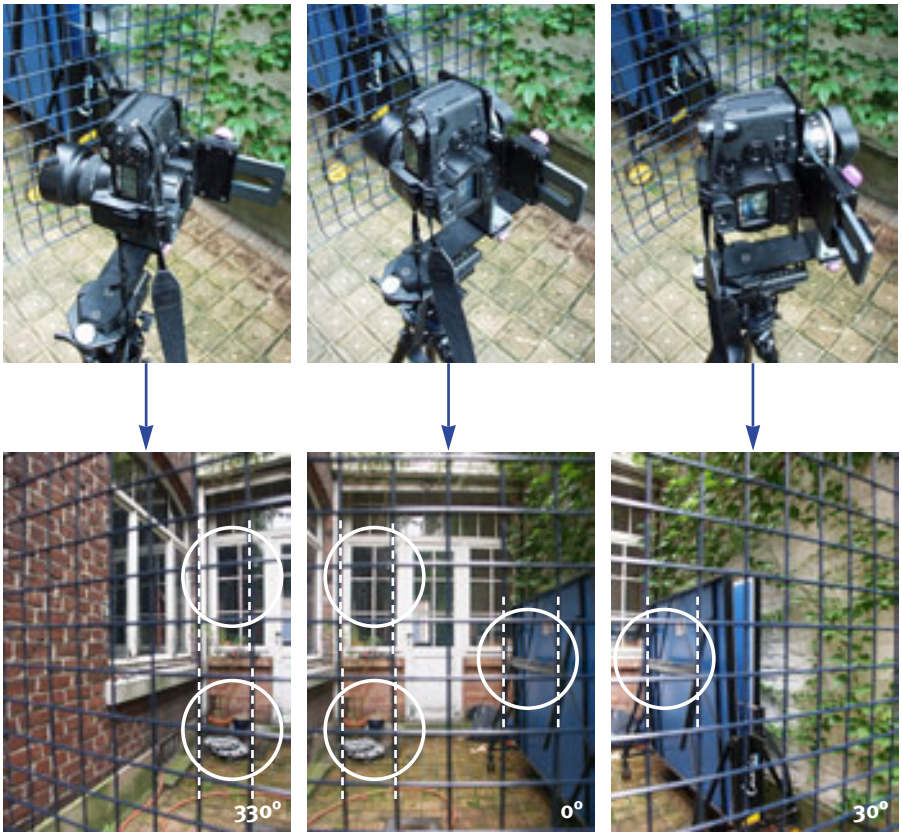
Tip! Level your camera perfectly at -90° *(towards nadir)* and match the centre of the viewfinder with the screw on the central axis of the spherical bracket. This is not always possible. In my situation, this screw is hidden by the rulers and by parts of the quick-release Manfrotto attachment plate.

Warning! *If you are using a camera with a zoom lens, lock the focal length at which you will be working (e.g. 28mm) as well as the focus point. Modifications to any of these two during the adjustments will alter the location of the entrance pupil and all settings would be lost.*

Step 2. Fine-tuning during horizontal rotation

The camera being perfectly levelled on the horizon *(inclination at 0° see spirit-level on the opposite picture)*, sweep the camera from left to right and observe carefully in the viewfinder *(or on the LCD screen)*, the movement of the background behind the grid. The grid is here the nearest foreground.

Check the Spirit level!



Here, the camera is not well positioned. The rotation axis is just 10 mm behind the entrance pupil. Note the shifts between the background and the verticals of the grid *(window frame, flower jars, table-tennis table, etc.)*.

Adjust the camera positioning on the bracket by moving it to the front or to the back and/or left or right *(as in step 1)* until no more shifting occurs between the background and the grid during a horizontal rotation.

The same views after fine-tuning the horizontal rotation. No more misalignments between the background and the grid in the foreground.

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Step 3. Basic adjustment

For a good adjustment the camera must also tilt on a virtual horizontal axis running through the entrance pupil of the lens.

Position your camera so that the centre of the lens *(as seen from the front)* is precisely at the same height than that of the tilting axis of the spherical bracket.

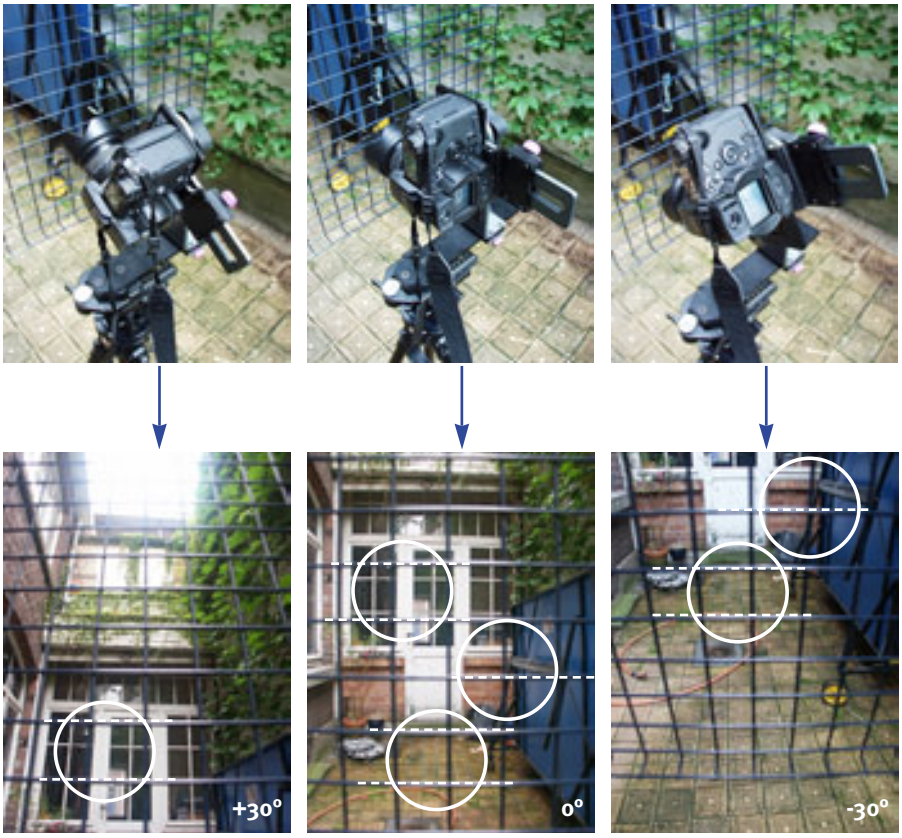
This basic preliminary adjustment can be measured by eyesight, or better with the help of a spirit level *(see also "Tip!" at step 1)*.

The centre of the lens and the tilting axis are on a same horizontal line.

Step 4. Fine-tuning during vertical tilting

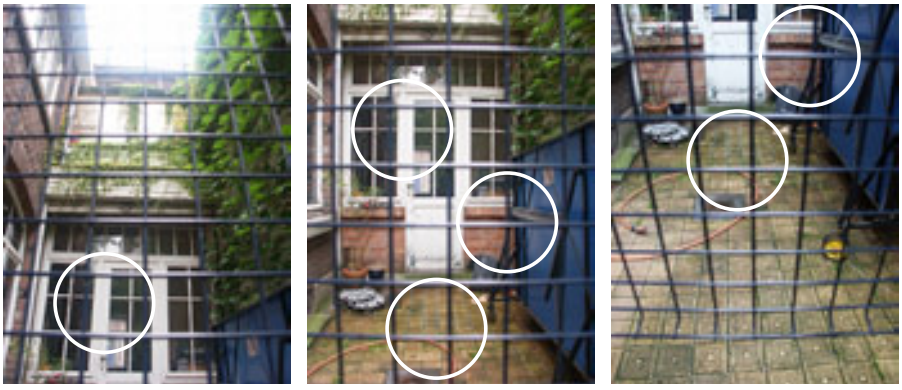
With the fine-tuning of the horizontal rotation done *(see steps 1 and 2)*, chances are high that the overall positioning of the camera is correct.

To verify or fine-tune the settings, you can proceed the same way this time tilting the camera up and down and observing carefully in the viewfinder *(or on the LCD screen)*, the movement of the background behind the grid.



Here, the camera is misaligned. The tilting point is simply 10 mm behind the entrance pupil. Note the subtle shifts between the background and the horizontals of the grid *(window frame, water hose, window sill, etc.)*.

If necessary, improve the camera positioning on the bracket by moving it to the front or the back and/or up or down *(as in step 3)* until no more shifting occurs between the background and the grid during a vertical tilt.



The same views after fine-tuning the vertical tilt. No more misalignments between the background and the grid in the foreground.
Your camera is now perfectly adjusted on the entrance pupil of the lens!

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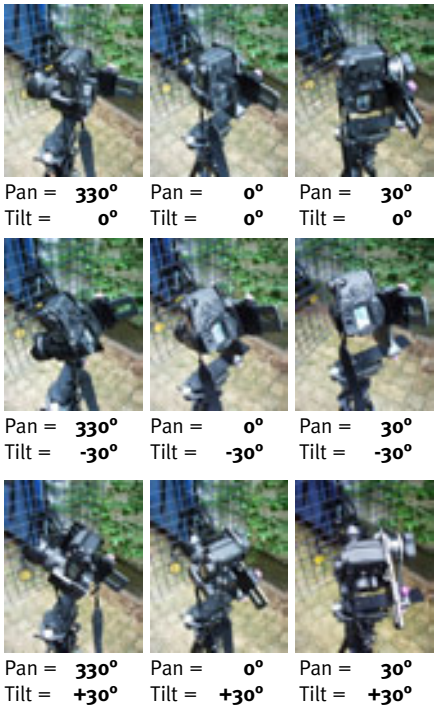
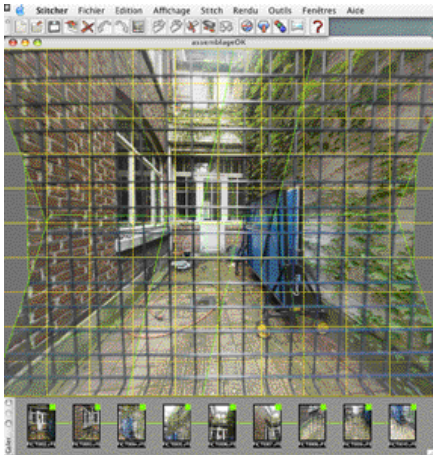


Different positions of the camera across nine test shots *(3 rows)*.

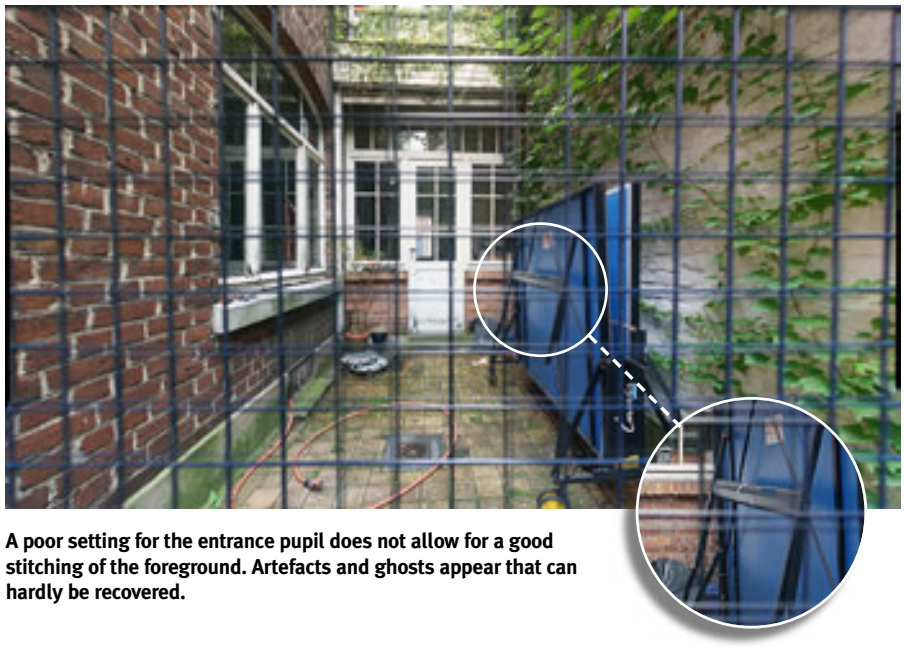


Stitching in Realviz Sticher 4.0.2

Proof by sight

Most programmes used to stitch panoramas adapt for small glitches in camera positioning with more or less distant subjects.

With a very near foreground *(fence, balcony, etc.)*, it is another story! It becomes impossible to stitch images together *(due to parallax errors)* if the 2 axis of the spherical bracket *(horizontal rotation and vertical tilt)* are not running precisely through the entrance pupil.



A poor setting for the entrance pupil does not allow for a good stitching of the foreground. Artefacts and ghosts appear that can hardly be recovered.

Here, the position of the entrance pupil has been perfectly located for the 2 axis *(horizontal rotation and vertical tilt)*, the stitching process is smooth and the result impeccable.

I hope you will find "**the grid**" useful and that it will help you achieve better results with your panoramas.
If it turns out that you do improve your panoramas, I would be happy to hear from you! ;-)

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