FOR A GOOD 3D RECONSTRUCTION...

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3D GRAPHICS
FOR CULTURAL HERITAGE

3 POINTS

- The subject must be adequate

- The photographic coverage must be adequate

- The photos must be good

We will give basic rules, try to follow them at the begin, and the more you got experienced, you will see some may be regarded only as "suggestions"

THE HARSH TRUTH

- Do not worry if your first set does not come out

- Do not worry if your *second* set does not come out

- Do not worry if your **THIRD** set does not come out

Try to understand what went wrong, retry.

Improve
Improvise. Adapt. Overcome

THE SUBJECT

Choosing an adequate subject IS part of the test

NOT ENOUGH TEXTURE

The tool must be able to find interesting points in the first phase, and then match all the pixels.

Avoid:

- Too smooth surfaces

- Too flat surfaces

- Flat colors

- Repetitive small patterns

AS IN 3D SCANNING…

The tool must be able to clearly see the surface, coherently, from all directions

Avoid:

- Dark objects

- Translucency / transparency

- Shiny / reflective materials

CRAZY OPTICAL BEHAVIOURS

Avoid materials with strange appearance or that change appearance depending on view direction

- Velvet, broccato, shiny fabrics (although IS possible to capture fabrics)

- Almost all gemstones

- Shimmering / holographic / color-shifting / speckle paints

- Brushed metals. Hairs and furs are possible, but will cause noise

- Interference materials (some kind of feathers, butterfly wings)

SIZE MATTERS

- **Too large**: difficult to cover and frame completely, difficult to reach all parts

- **Too small**: problem with focusing. Do you have a macro lens?

- **Too tall**: you'll never be able to photograph top part

- **Too close to ground**: covering from bottom will be a problem

LOGISTICS

Always ask yourself:

- **Can I reach all parts from multiple angles?**

- **Is it accessible?**

- **Can I get back, if needed?**

COMPLEXITY

Objects with complex geometry, undercuts, hard-to-see areas are extremely more difficult to do, and require many more photos.

This object has been made by a student, but it took 169 photos, and a lot of work, to be completed

GOOD CANDIDATES

Suitable material, size, accessibility

Texture/color details at all scales

Geometric details at all scales

THE COVERAGE

A good 3D depends on a good photographic survey

REQUIREMENTS

In order to be reconstructed, a surface point must be visible and recognizable from MULTIPLE directions (at least 3, 4+ is better).

It is better to shoot a lot of pictures than few ones… but:

- More photos → more processing time and resources

- Above 100, things get really slow for notebooks and older PCs

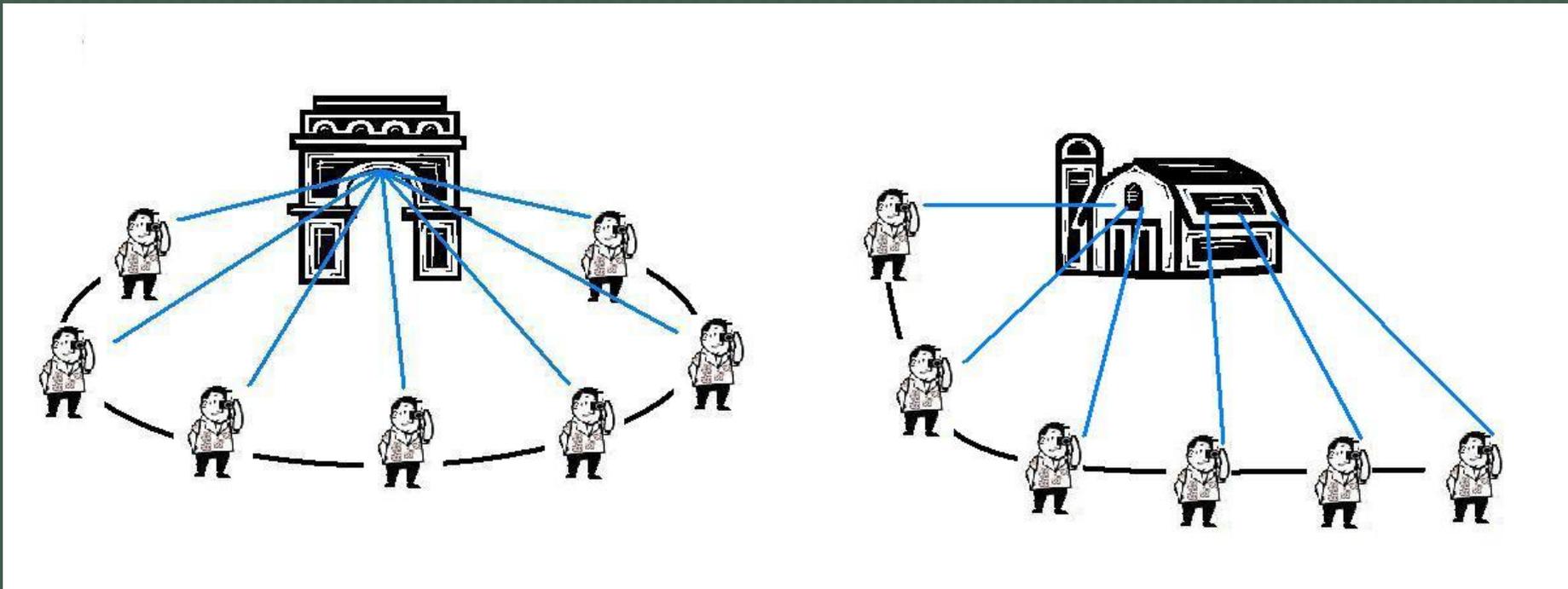- Some tools (e.g. Zephir free version) have a limit on the number of input images.

For this test, try between 30 and 100, 50-60 is a good compromise

BASIC SCHEME - HORIZONTAL

Go around the object, shooting as you move.

The viewing angle between images should not be too large, i.e. adjacent images should not be too far apart

Consider 15-20 degree as a good step.

BASIC SCHEME - VERTICAL

Work also on the vertical axis. Shoot at the object from above and below, at different inclinations.

Shoot with the camera above your head and from the ground.

A selfie stick may help.

BASIC SCHEME - DISTANCE

Cover the object from different distances.

Closer → more local detail in photos → more local detail on 3D

However, it is more complex to align images not framing the whole object!

A set of photos framing the WHOLE object is always needed.

STRATEGY

Far enough to frame the whole object plus some space around, go around the object in a circle, shooting every 15-20 degrees, covering it completely. Do other rounds at different height/inclination (above and below).

Get closer, do rounds at different height/inclination, following more closely the object profile.

Finally, work on undercuts, concavities, complex areas, always shooting every few degrees, covering each area from multiple angles.
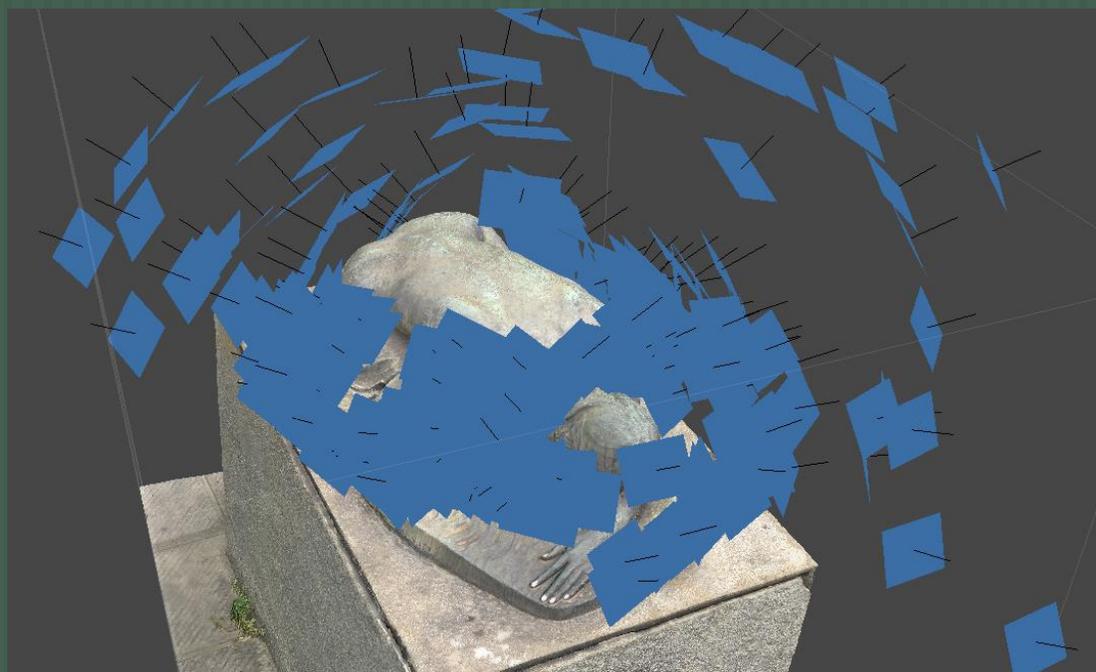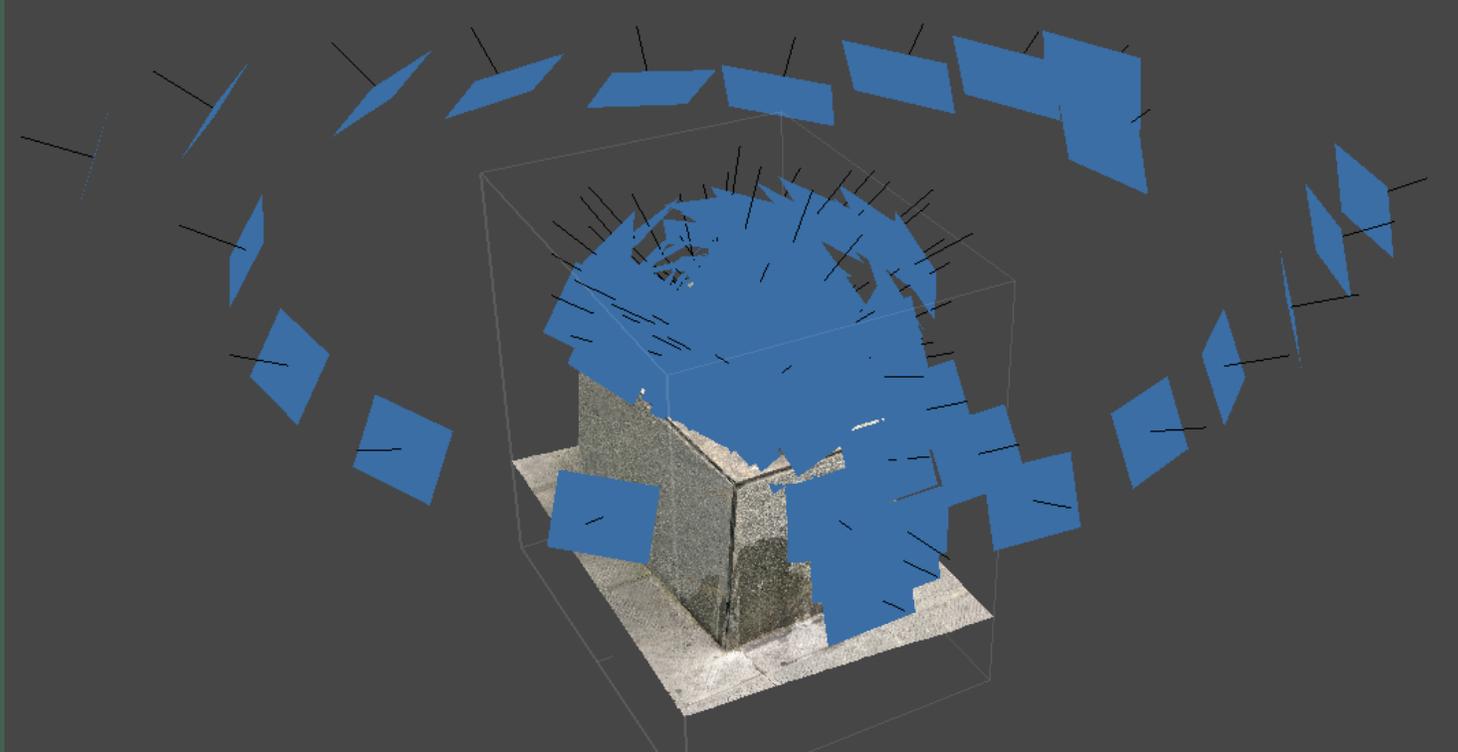
ZOOM - FOCAL

- Some tool DO NOT accept photos taken with a different zoom (focal)

- In any case, a set with different zoom values are more difficult, and may fail or have too much error

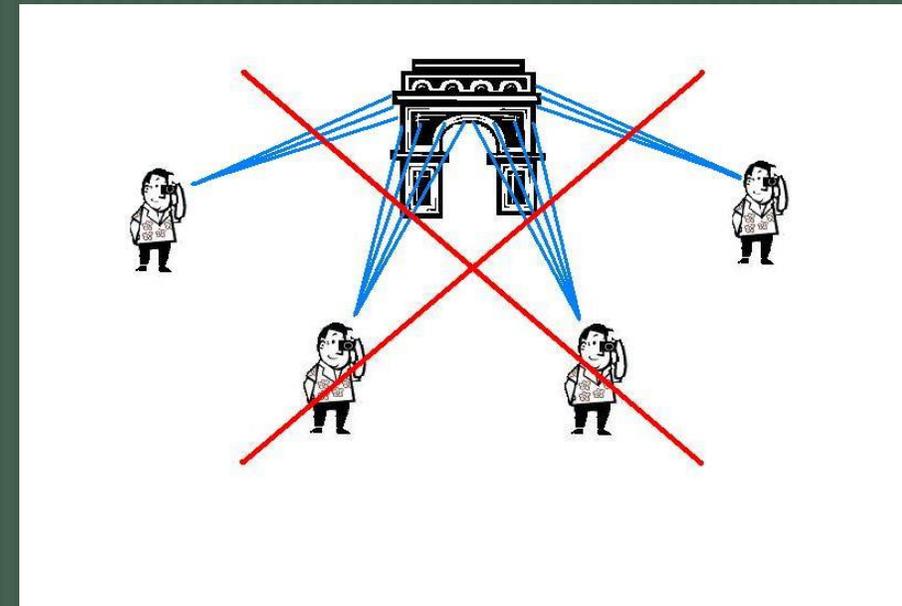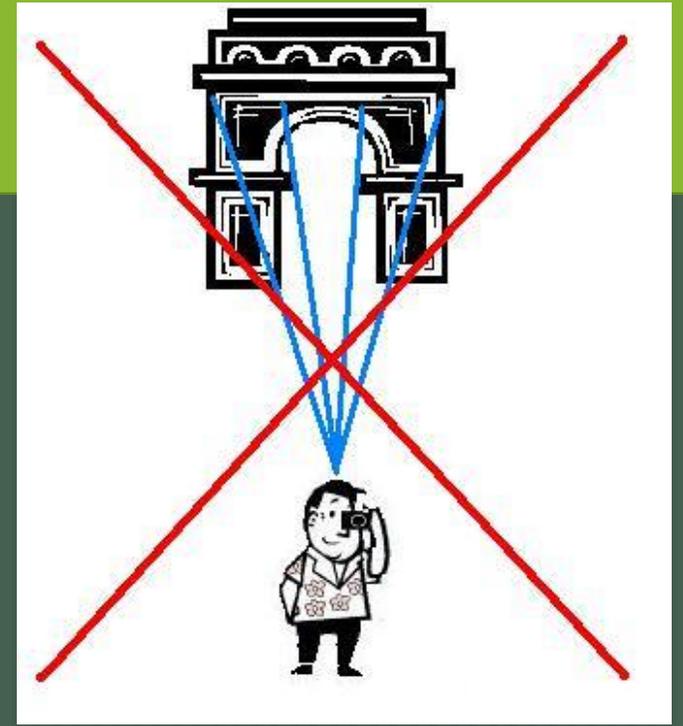Keep the same zoom for the whole digitization

A prime lens works better (less lens elements $\rightarrow$ less distortion)

On cellphones, NEVER use zoom.

NOT A PANORAMA

Keeping the same shooting position and just tilting the camera is BAD

If the object is too large to frame completely, and you need multiple shots to cover from a specific direction, always move a bit between shots.

INSIDE OUT

For reconstructing a room from the inside, walk the perimeter, looking at the opposite side

In this case you may take more photos for each point, but NOT like a panorama (small or no overlap, jitter a bit the camera position)
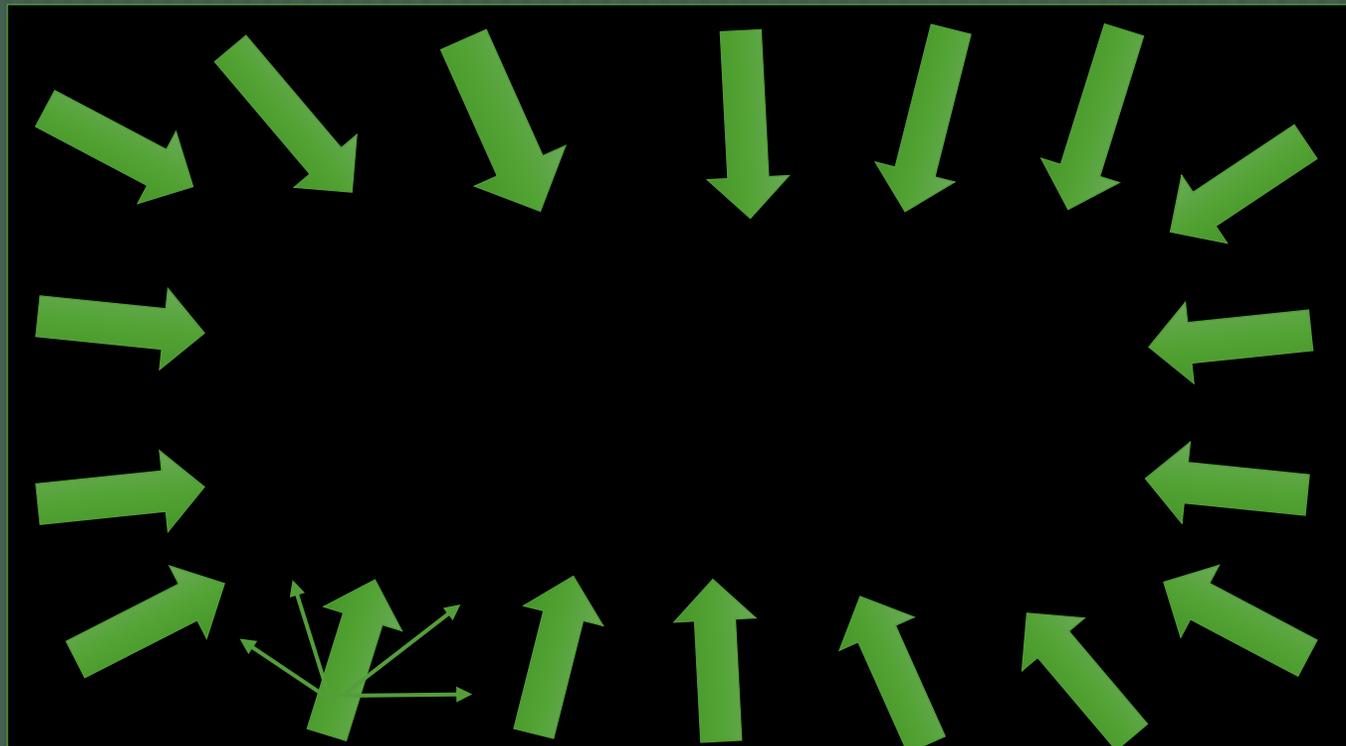
BACKGROUND MATTERS

For the initial camera calibration+orientation, matches are searched on the WHOLE image, interesting points around the object helps this step a lot!

Matched points in the background are useful to estimate focal length.

TRICK: add feature-rich objects around the subject. When shooting at an object on a table, I often place newspapers around

GOING AROUND ↔ SPINNING

All these instructions assume the object STILL and the camera MOVING.

For small object, you may think of rotating the object in front of the camera, with a turntable.

In this case, there should be A FLAT BACKGROUND, to avoid the software picking points on the background that will remain stationary, while the subject moves, making impossible the calibration/orientation.

It is not advised as your first try!

GOING AROUND ↔ SPINNING

- In some software (especially free ones) will NEVER work.

- You will have to build an appropriate setup.

- You may still have to MASK OUT the background on all images.

- The image alignment will rely entirely on the object, this makes things more complex.

However:

- this is how professionals work on small objects, much more controllable lighting, easier to cover the object in a regular way, no external elements to clean.

- Some tools are implementing an "automatic background-excluding" functionality

LIGHTING CONDITIONS

Best situation: **uniform**, **unchanging** illumination

- An overcast sky is perfect.

- Avoid shooting in the dark (do I have to say it?).

- Avoid backlight shooting. (or, at least, expose properly).

- Do not to shade the object when moving.

- No moving lights.

- NO FLASH. Unless the flash is able to light the whole object completely and evenly.

NO!

THE PHOTOS

In the end, the software will use pixels

EQUIPMENT

What kind of camera should I use?

More pixels = more 3D points = longer processing time, may be prone to noise

Using 20-30 Megapixel photos will take forever and possibly crash the tools on less powerful PCs, around 10 is ok, and the result will be better than expected

A good lens is more important than the number of megapixels (this is **always** true).

Good lens → less distortion → better result

Good lens → more light → better result

EQUIPMENT

A good compact camera might be enough.

DSLR have better lenses and sensors, but are more complex to control.

Mirrorless are ok, easier than DSLR, but avoid pancake lenses.

Cellphones might be ok.

P-mode or AUTO are not your enemy. Unless you know how to properly set exposure and aperture, use them.

Focusing and exposing on the correct spot HELPS A LOT.

Try to avoid "beauty", "enhancing", "auto-fixing" settings.

EQUIPMENT

A tripod helps in keeping the camera still for longer exposure times. However, is time consuming to move around an object with it.

Can be used to raise the camera high above your head.

When using a turntable, always use it.

Some tools are able to use GPS data in the photos EXIF.

e.g. Metashape reads and use GPS data from photos form some iPhone and Androids. If so, the model will appear already scaled and oriented (not sure If only the PRO version does it).

Photos from drones have good GPS, and it is used by most commercial tools.

Cameras with built-in GPS save shitty data, not good enough for photogrammetry.

SHARP

Photos need to be **SHARP**; avoid blurred and out-of-focus images.

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PHOTOS - MANIPULATIONS

- **DO NOT CROP**: when cropping, the optical center is no longer close to the image center. This makes calibration more difficult. (UNLESS you crop preserving the center)

- **DO NOT FILTER**: (UNLESS you know exactly what are you doing, and use the same parameters for all images)

- **DO NOT COMPRESS**: avoid multiple saving in jpg; if using a cellphone get the photos via USB, not from Google Photos or iPhotos; do not send images though WhatsApp

- **DOWN-SIZING IS OK**, provided you use the same parameters for all photos.

- **RAW SHOOTING**: some tools can work on RAW images. This helps, but sometimes it is not worth the effort, especially for your first try. Shooting in raw and then do a careful development works well.

PHOTOS - MANIPULATIONS

- **IMAGES WITH DIFFERENT ORIENTATION (LANDSCAPE – PORTRAIT)**

  Most cameras/phones auto-rotate the photo according to device orientation. In most cases, this image orientation is saved in the EXIF, and this info is read by the software, and used accordingly.

  However, a camera may fail to orient a photo properly, or the EXIF data is wrongly saved.

  1. Try using the images as they are.

  2. If something goes wrong in the alignment, check the photos' orientations. Do the wrongly-aligned photos have a wrong orientation? Do the wrongly-aligned photos have a DIFFERENT orientation from the majority of the other photos?

  3. If so, try removing or rotating the images. Be careful when rotating the images, some image-processing software just rotate the pixels, but do not update the EXIF.

QUESTION TIME

Thanks for your attention

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