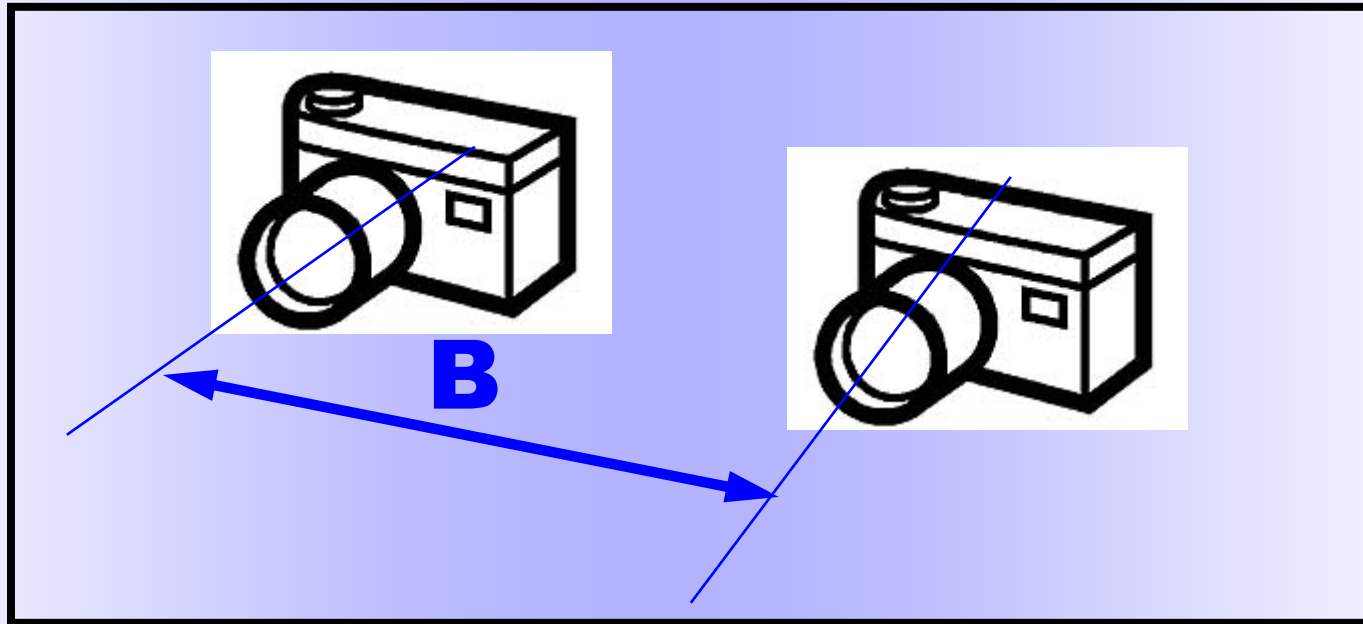


How to take

SINGLE CAMERA

Sequential 3D Pictures



By George Themelis

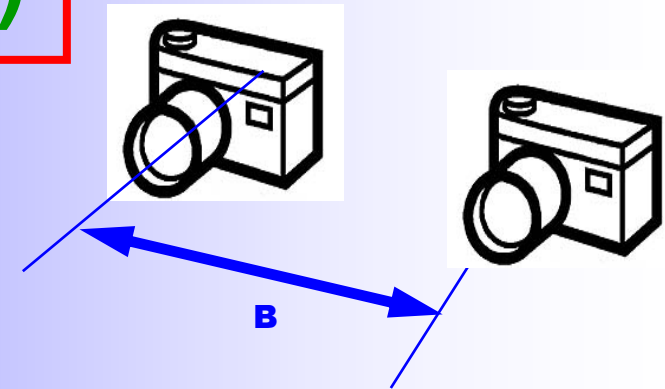
Why?

Why?

(+) Inexpensive & readily available

(+) Flexible Stereo Base (B)

(+) Interesting pictures



Today with digital photography & software alignment is the best time ever to experiment with single camera Sequential 3D Photography

Why Not?

(-) Limited to Stationary Objects

(-) More advanced

**Single camera sequential 3D photography
supplements 3D photography with a stereo camera**

Single Camera 3D

1. Tools

2. Techniques

3. Post Processing

Equipment

<i>Existing 3D Camera</i>	<i>Smartphone</i>	<i>Newer Camera</i>
<p data-bbox="79 354 577 698">(+) No expense (+) Advanced 3D (Fuji) (-) Older</p>  <p>The image shows two 3D cameras. The top one is a black Fujifilm 3D HD camera with two lenses and a flash. The bottom one is a black Panasonic Lumix 3D camera, also with two lenses and a flash.</p>	<p data-bbox="682 354 1354 1161">(+) Always with me (+) Unobtrusive (+) 3D Apps (+) Large Screen (+) Small Lens (+) Good Quality (-) Small Sensor (-) No optical zoom (-) No camera controls</p>  <p>The image shows an iPhone smartphone. It is shown from the front, displaying the home screen with various app icons, and from the back, showing the silver metal casing and the Apple logo.</p>	<p data-bbox="1411 354 2016 1161">(+) Larger Sensor (+) Optical Zoom (+) View finder (+) Tilt Screen (+) Camera controls (+) Burst Shooting (+) Stabilization (+) Macro (-) Expense</p>  <p>The image shows a black Panasonic Lumix camera with a lens. It is a compact camera with a lens that can extend outwards. The Lumix logo is visible on the top right of the camera body.</p>

What Subjects to Photograph?

Moving objects are the biggest enemy of single camera hyperstereos. Small movements can be tolerated but hyperstereos with people or moving traffic are impossible.

This still leaves a lot of subjects possible:

- **Buildings / Architectural Details**
- **High rise Cityscapes**
- **Landscapes / Nature (without wind)**
- **Aerial 3d hyperstereos**
- **Tabletops**
- **And lots more!**

Techniques

Types of pictures:

- I - Observer Moves
- II - Platform Moves
- III - Subject moves

Classification based on stereo base:

- ↔ Normal 3D
- ↓ Hypostereo
- ↑ Hyperstereo

Concerns:

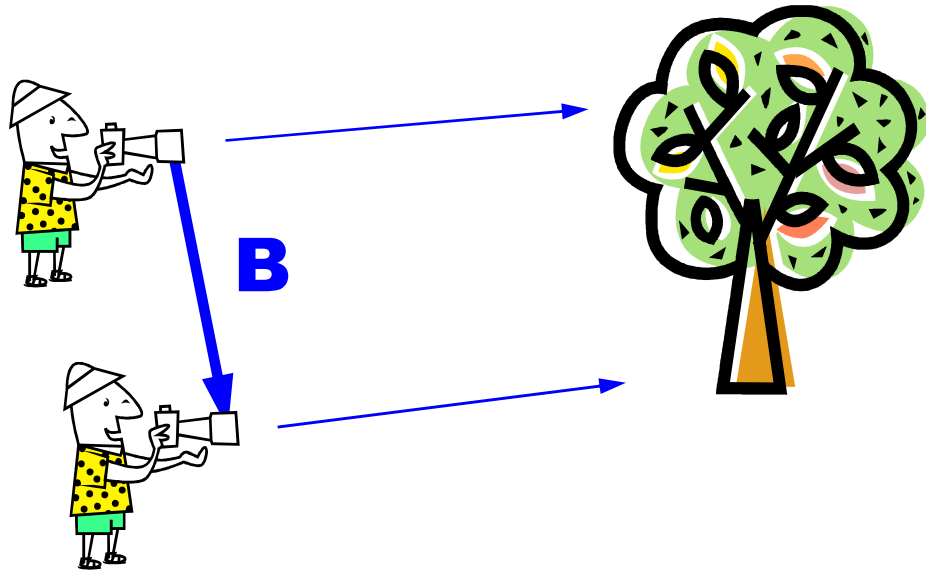
- Alignment
- Amount of movement
- Direction of movement (L→R, R→L?)
- Number of pictures (bracketing)
- Use of Flash

Interesting Effects:

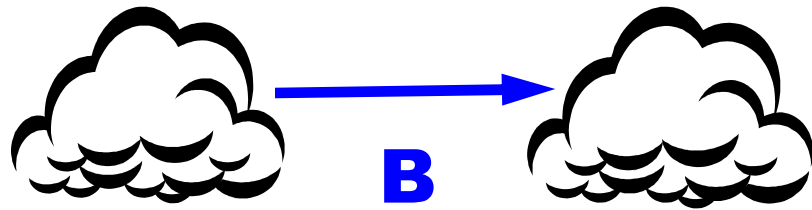
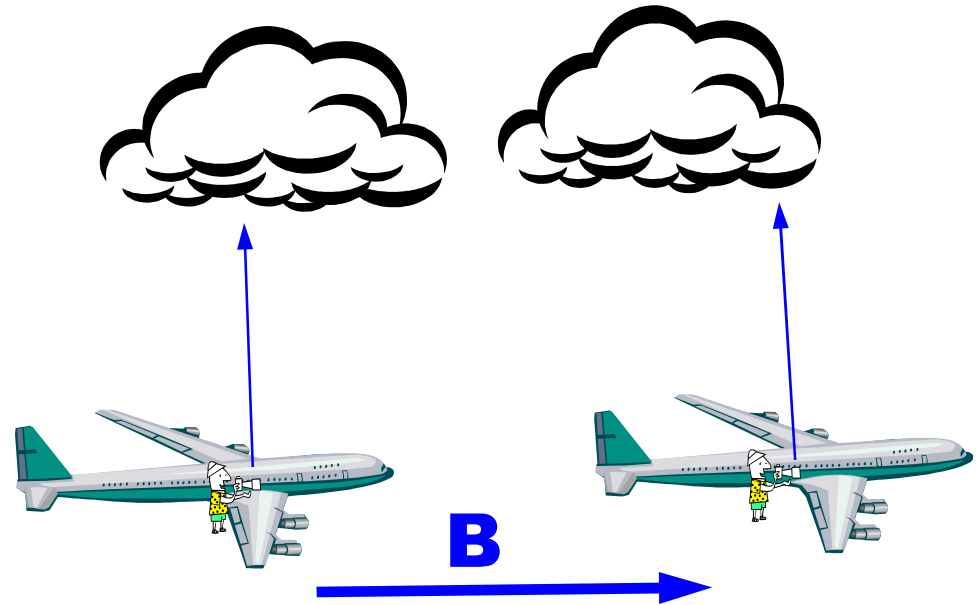
- Hyper/Hypo
- Burst shooting
- Low light
- Extreme Focal Length
- Shadows / Reflections / Tricks

I. Observer Moves

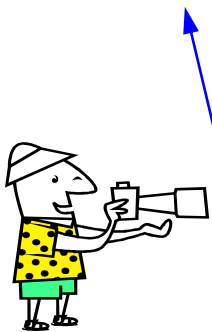
Techniques



II. Platform Moves



III. Subject Moves

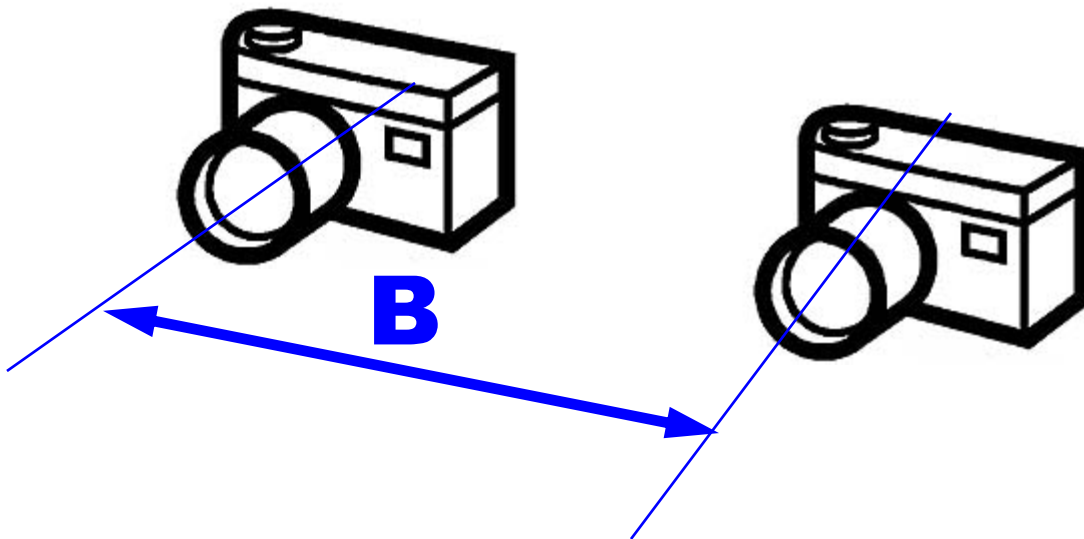
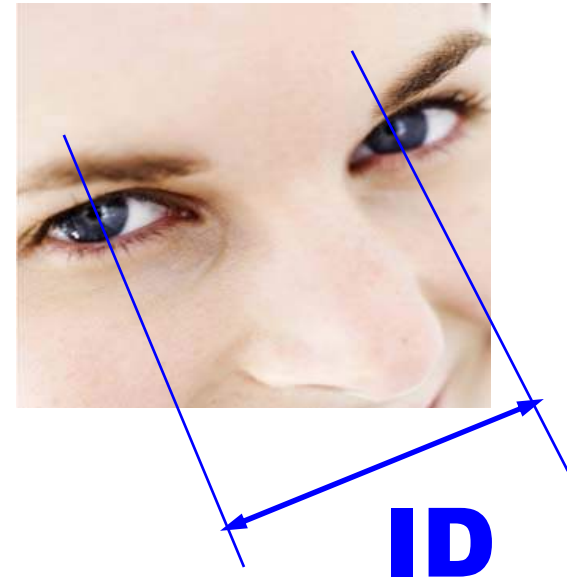


Classification based on B

Hyperstereo $B > ID$

Normal Stereo $B \sim ID$

Hypostereo $B < ID$



“Man is the measure of all things”

Protagoras (Πρωταγόρας) (ca. 490– 420 BC)

Concerns

- **Alignment**
- **Direction of movement** ($L \rightarrow R$, $R \rightarrow L$?)
- **Amount of movement**
- **Number of pictures (bracketing)**
- **Use of Flash**

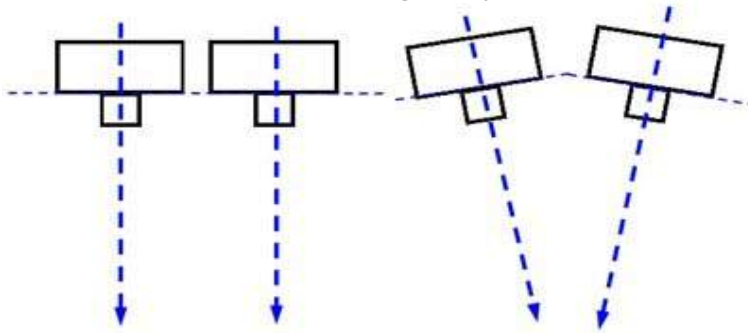
Alignment

Keep the camera perpendicular to the direction of movement

1. Convergence

Leads to differential keystone distortion

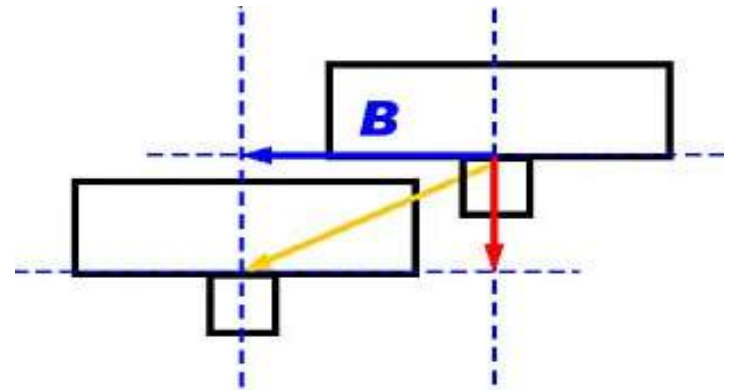
Can be corrected digitally, if done in moderation



2. Change of Distance to Subject

Changes size of near versus far objects

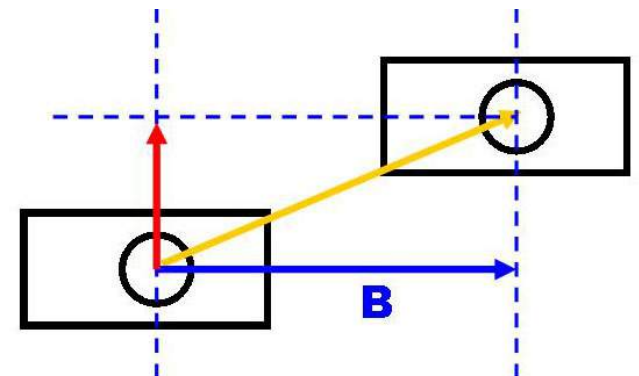
Cannot be corrected digitally - avoid



3. Change of Elevation

Changes field of view

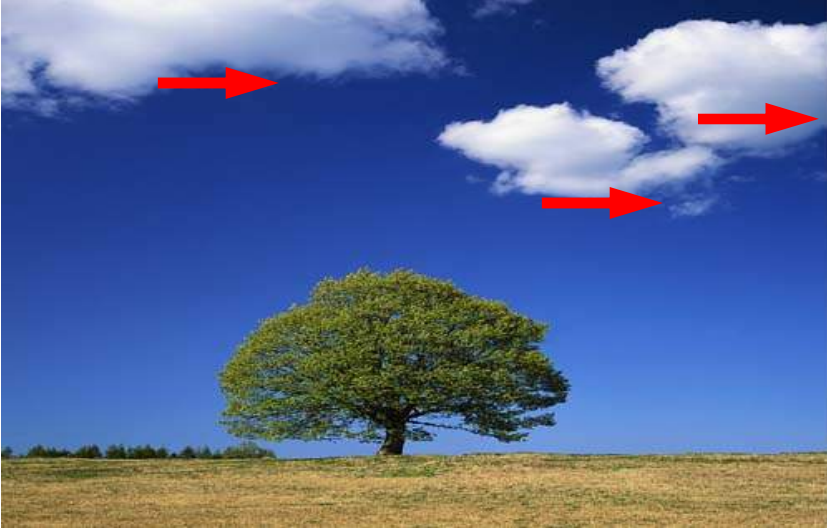
Might need to rotate the images to correct



Errors, if small, will most likely be unnoticed

Also, many errors are proportional to the amount of depth (more depth = more error)

Direction of Movement



Normally, I take the left picture first but some times there is a reason to take the right the picture first.

- **Moving with the clouds, pushes the clouds back**
- **Moving against the clouds, pulls the clouds forward**

For the Fuji: The order of pictures affects the previewing. If the camera is set to take the left picture first and you shoot the right picture first, the stereo pair will be reversed (pseudo) on the screen.

Amount of Movement

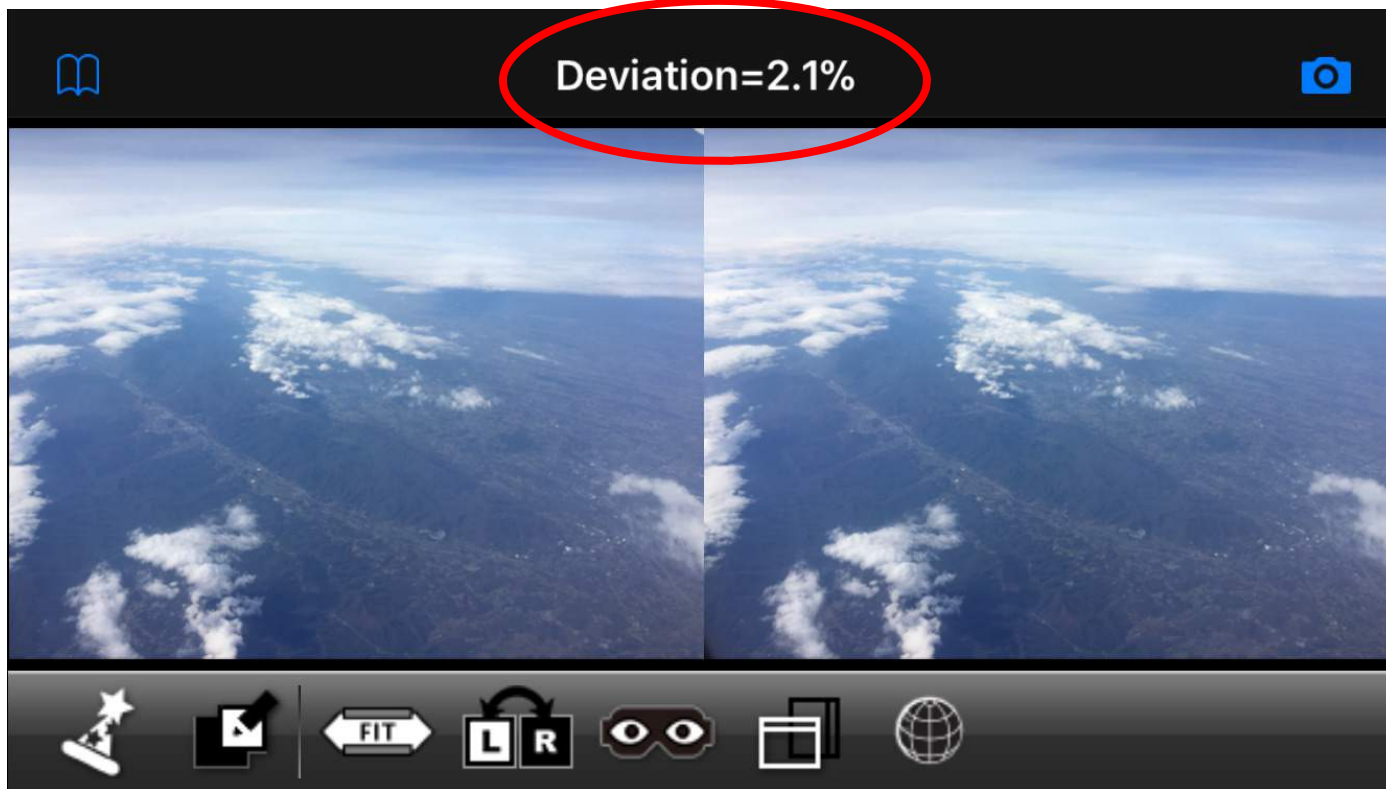
How much to move?

This is the age-old question and a source of anxiety for beginners in stereo. Paul Wing answers this in his own unique way:

“The mathematical genius spouts the numbers, but seldom gets around to making good pictures. In real life, you simply try a few, and profit from your mistakes.”

- **Take your chances**
- **1/30 of nearest object**
- **Use “maximum deviation” formulas based on Inear, Ifar, F**
- **Measure deviation w/smartphone & app**

Smartphone Apps



Matsui Suto (2011):
3DSteroid (Android)
i3DSteroid (iPhone)

Smartphone becomes similar to the Fuji 3D camera in “Advanced 3D Mode”

After you take the first picture, you see an **outline (ghost image) of this picture which helps with the alignment of the second picture.**

After you take the 2nd picture, you can see the stereo pair on the screen (freeviewing might be required, but other options + viewers are also available)

You also see a **value for the deviation,** which can alert you that something might be wrong (too much/little shift/depth)

Optimum Amount of Deviation?

Two extremes

1. Too little depth

2. Too much depth

- Between these two EXTREMES, there is a lot of ground for great stereo pictures.
- **My recommendation: Deviation = 1.0 to 3.0 %**
- Sometimes “less is more”. Be conservative!
- Bracket stereo base if you can

Use or not use the App?

The app helps with alignment, and provides instant feedback via the deviation value and possibility of viewing the pair in 3D

I always **save the original images** (this is an option recently added to the app) and **use SPM for alignment** later at home, because the **resolution** and **alignment** of the pairs is **better than those saved by the app**.

There might be reasons not to use the app (use camera phone or a 2D app instead):

- Better control of phone's camera (via 2D apps)
- Bracket the stereo base by taking 3 (or more) pictures instead of 2

Number of Pictures (Bracketing)

A Minimum of 2 pictures is required 😊

One strategy: Every time double the distance/time
For 3 shots use (0, 1, 2). Then combine to get: 1, 2, 3

A: 0

B: 1

C: 2



For 4 shots use (0, 1, 2, 4)

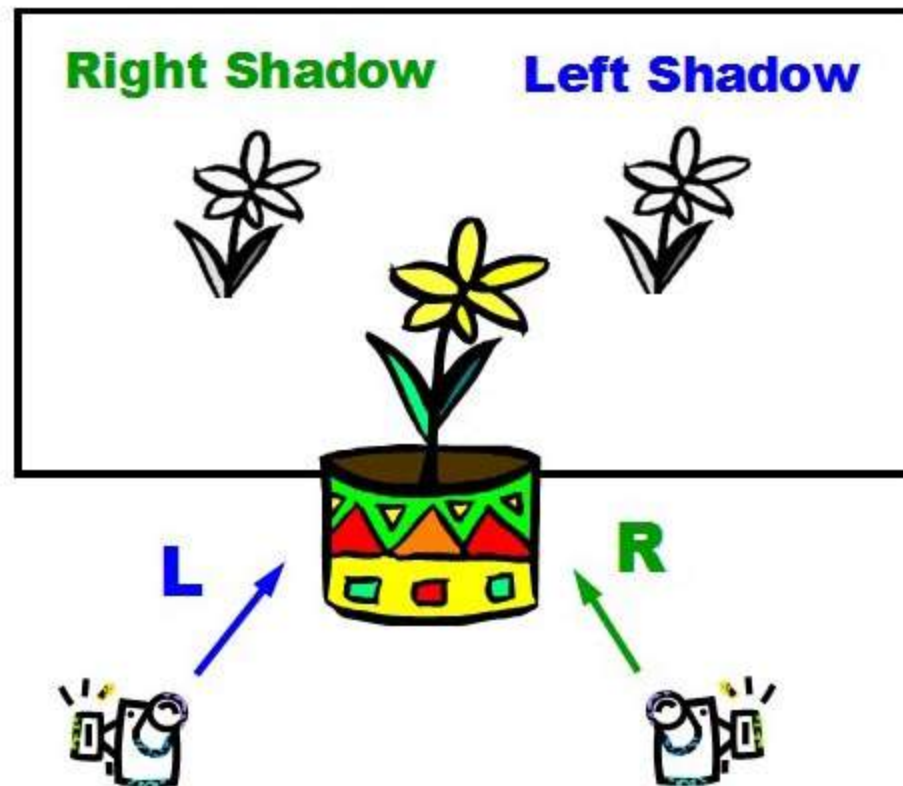
Then combine to get: 1, 2, 3, 4, 5, 6, 7

Note: Like exposure, doubling will make a difference, 1.5 times will likely not matter, so instead of wasting time, I would use these combinations: 1, 2, 4, 7

Flash in Sequential Stereo

Flash must stay stationary! Do not move with camera.

If moved with camera and shadows are formed, then the shadows will appear pseudoscopic!



Interesting Effects

- **Hyper / Hypo**
- **Burst shooting**
- **Low light**
- **Extreme Focal Length**
- **Shadows / Reflections / Tricks**

Burst Mode

<i>Burst Mode</i>	<i>Frames per second</i>
Low	2
Medium	5
High	10
Super High	50

Example: Car travelling with 60 mph

- In one second, the car has moved **27m**
- With a burst rate of 50 fps, **the stereo base between two shots is only about 0.5m** (~20 inches). This is a mild hyperstereo and works well when shooting out of a car/bus window.
- In combination with a **very high shutter speed** (often higher than 1/1000s), the pictures look like they were taken with a twin camera system from a stopped vehicle.
- The fact that the time interval between shots is small (1/50s) also means that **any movement in the scene is minimized**, so slow moving cars or people, for example, will appear still.

Moonlit Pictures

Camera Variable	“Sunny 16”	My Exposure	Added stops	“Looney 16”
f-stop	f16	f1.4	7	f16
ISO	100	3200	5	100
Shutter speed	1/100s	~1s	7	44 mins
Added stops			19	18

Long Zoom Range

Panasonic FZ80 (20-1200mm)

<i>Image Size (MP)</i>	<i>Extended</i>	<i>Intelligent</i>	<i>Digital</i>
18	1200	2400	4800
9	1700	3400	6800
4.5	2400	3670	9780

- **Extended Optical Zoom:** When using a smaller image size, the zoom can be extended without any deterioration of the image quality. When the image size is cut in half, the zoom increases by $\sqrt{2}$
- **Intelligent Zoom:** According to Panasonic, intelligent zoom can extend the focal length by 2x with minimal image deterioration. I am not sure how this works.
- **Digital Zoom:** The camera crops and enlarges the image. With digital zoom it is possible to extend the focal length by 4x, but the image quality deteriorates.

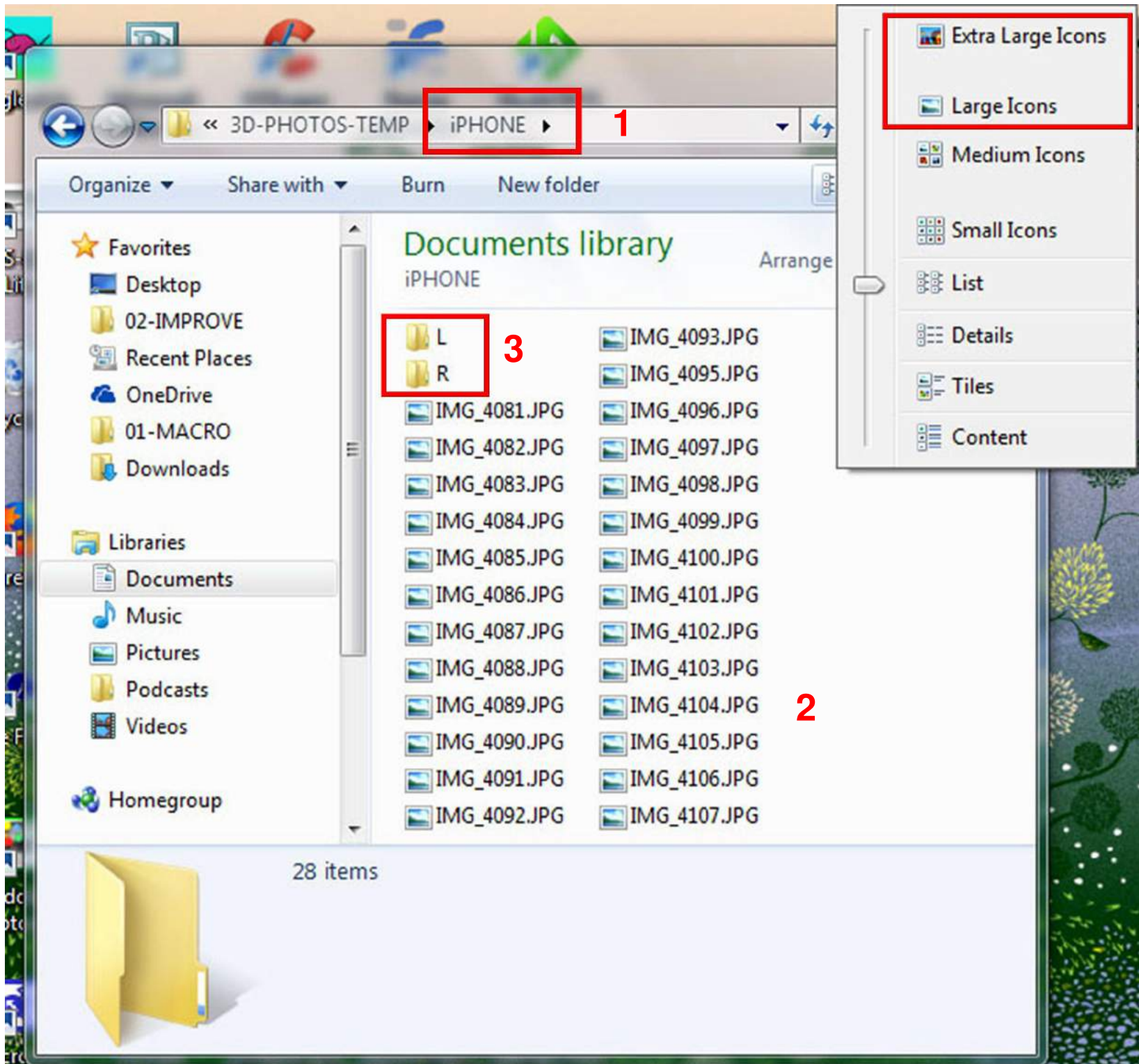
In theory **only the optical focal length matters**. Any operation to increase this is done digitally (by cropping or cropping & enlarging) and this can be done either by the camera, or (better) later by the user and software.

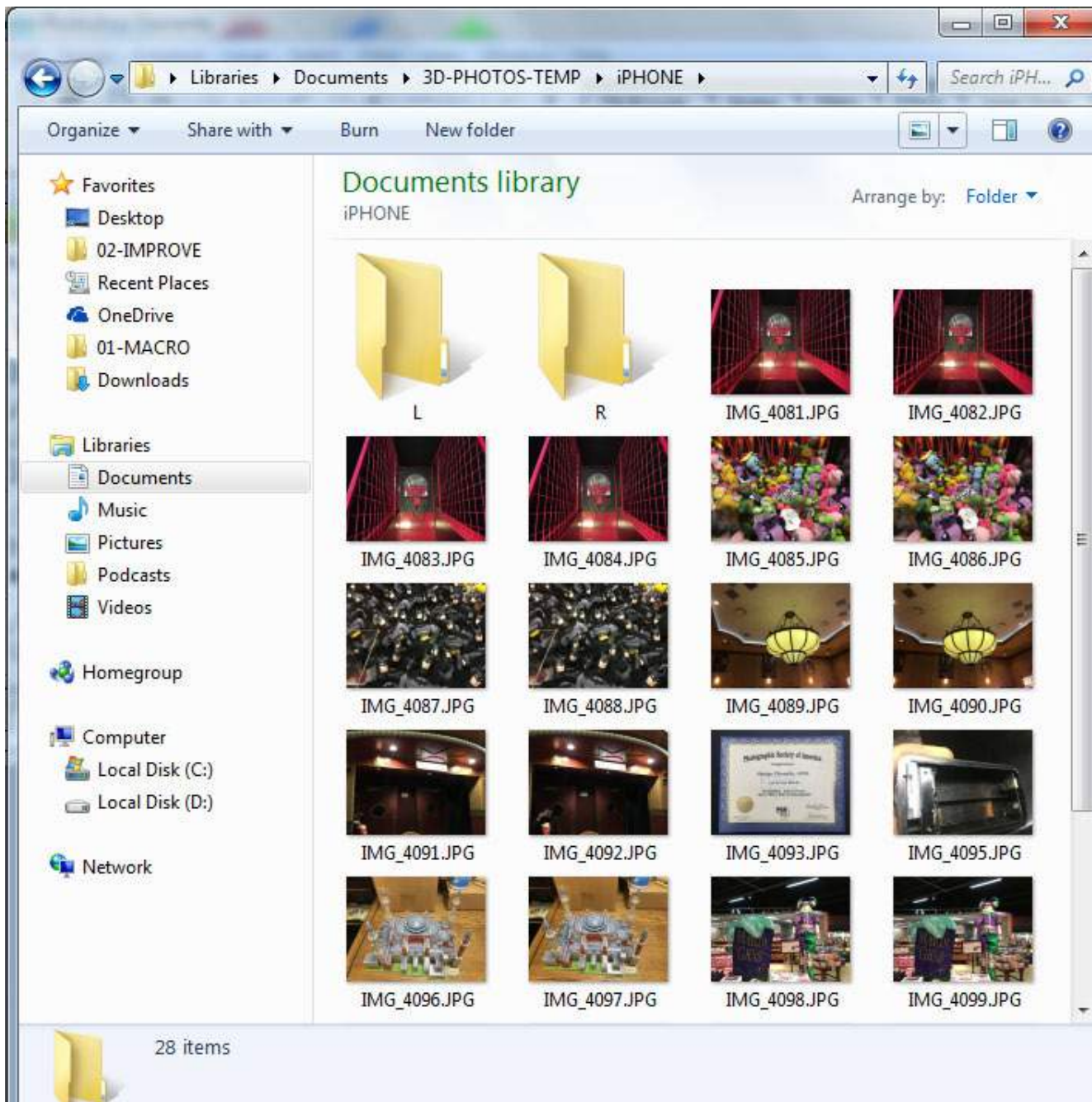
In practice, **there are advantages in being able to extend the focal length while taking the picture**. It allows the photographer to see, frame, focus, expose the subject better.

Processing (via SPM)

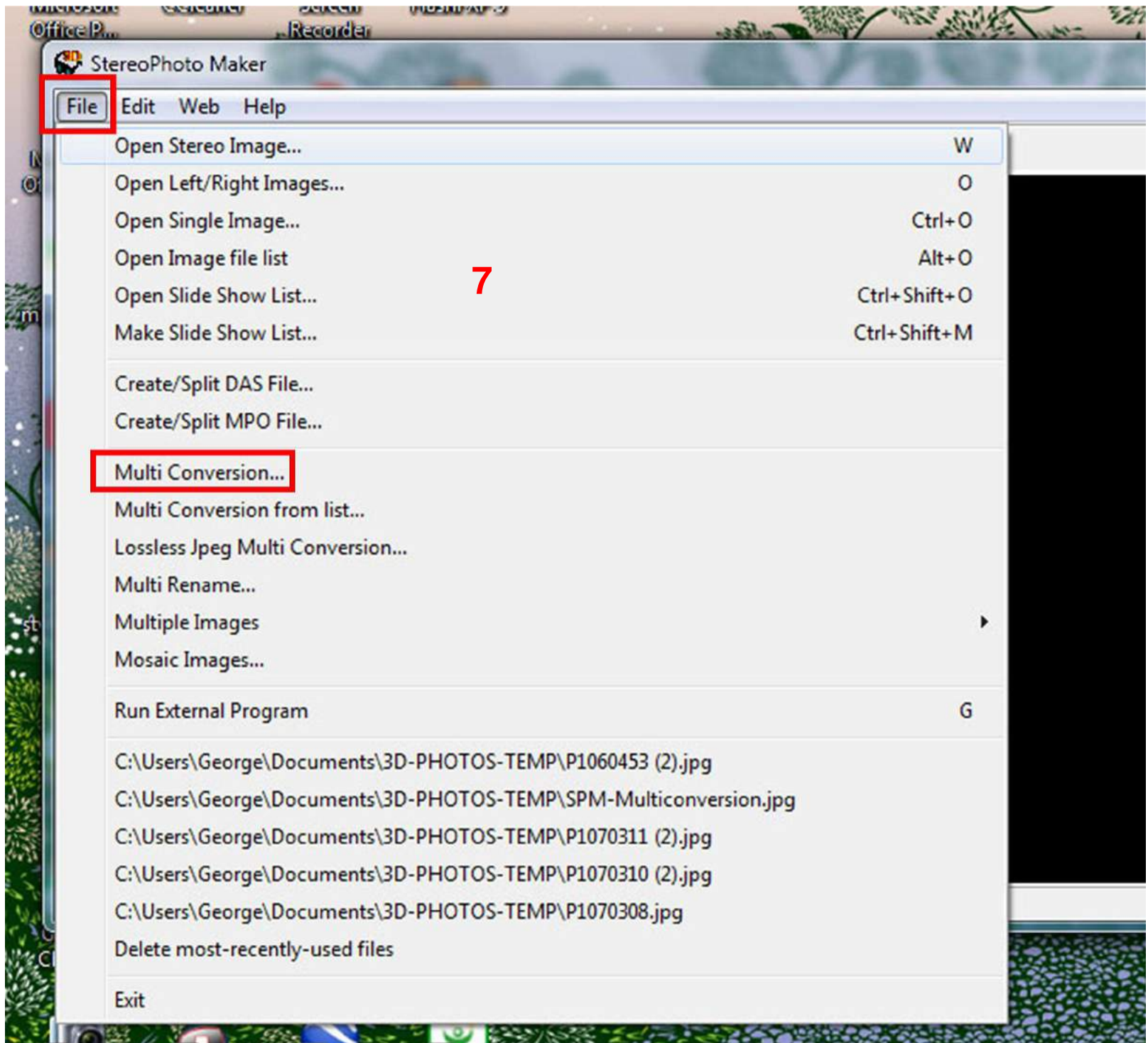
1. Create a folder to hold the images
2. Transfer all images from the camera to this folder
3. Create two sub-folders (R, L) to hold R, L images
4. Change the view to large icons
5. Freeview the pairs (if you can)
6. Transfer L image to L sub-folder & R image to R sub-folder
7. Open SPM (view/align manually or do multiconversion)
8. Go to Multiconversion and setup the screen
9. Convert all files
10. View images and make final changes

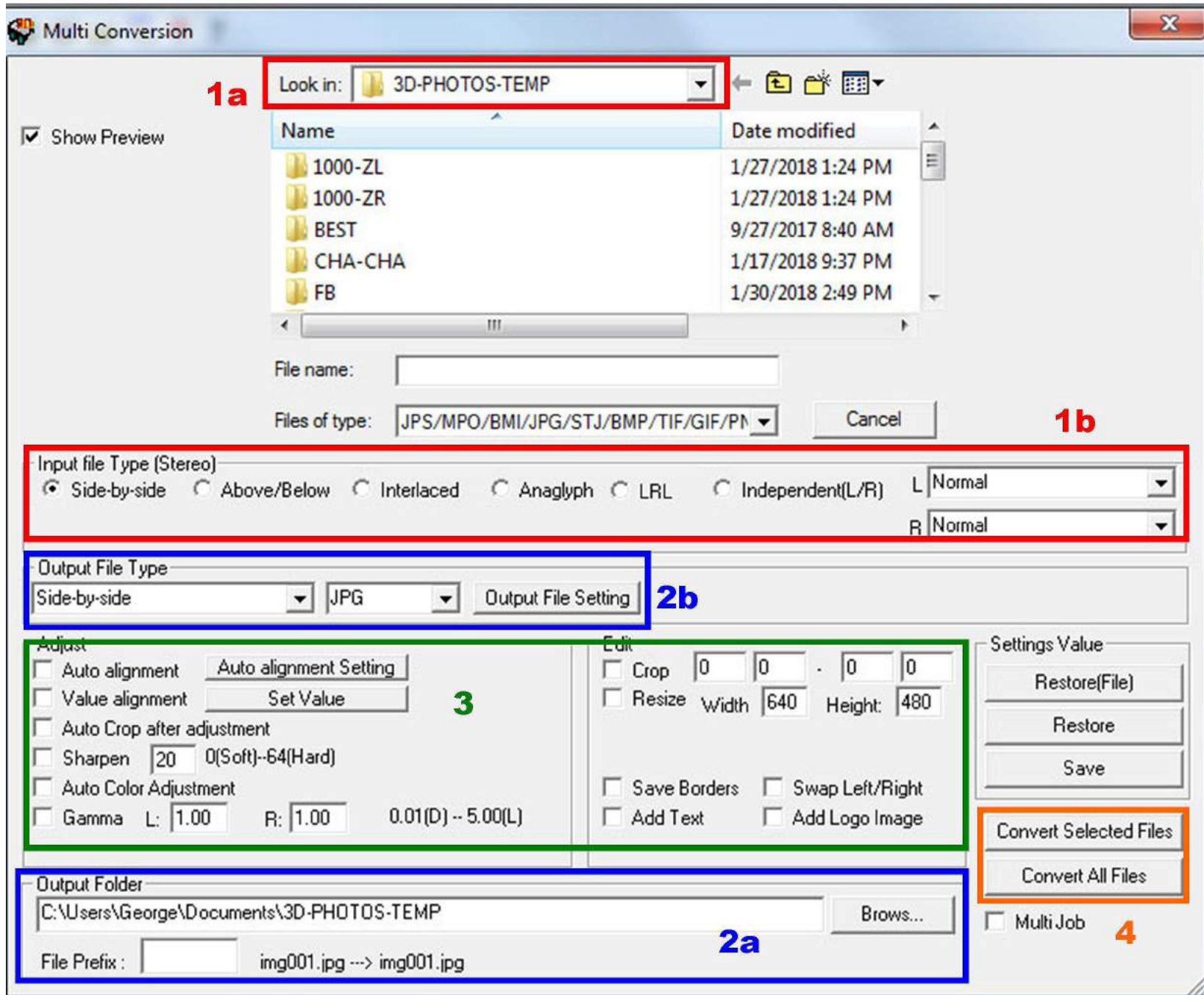
Advice: Do not wait!



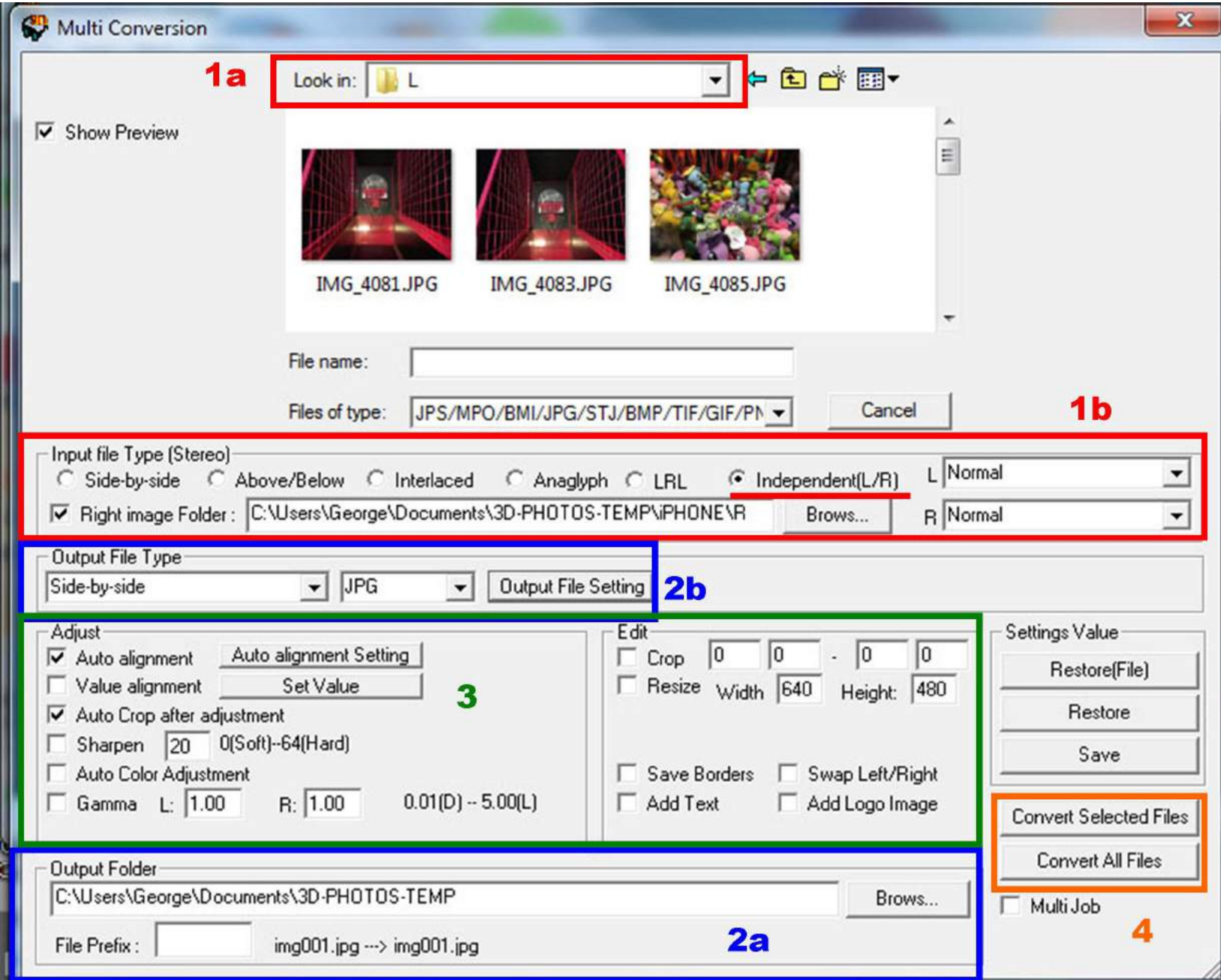


5, 6





8



1a

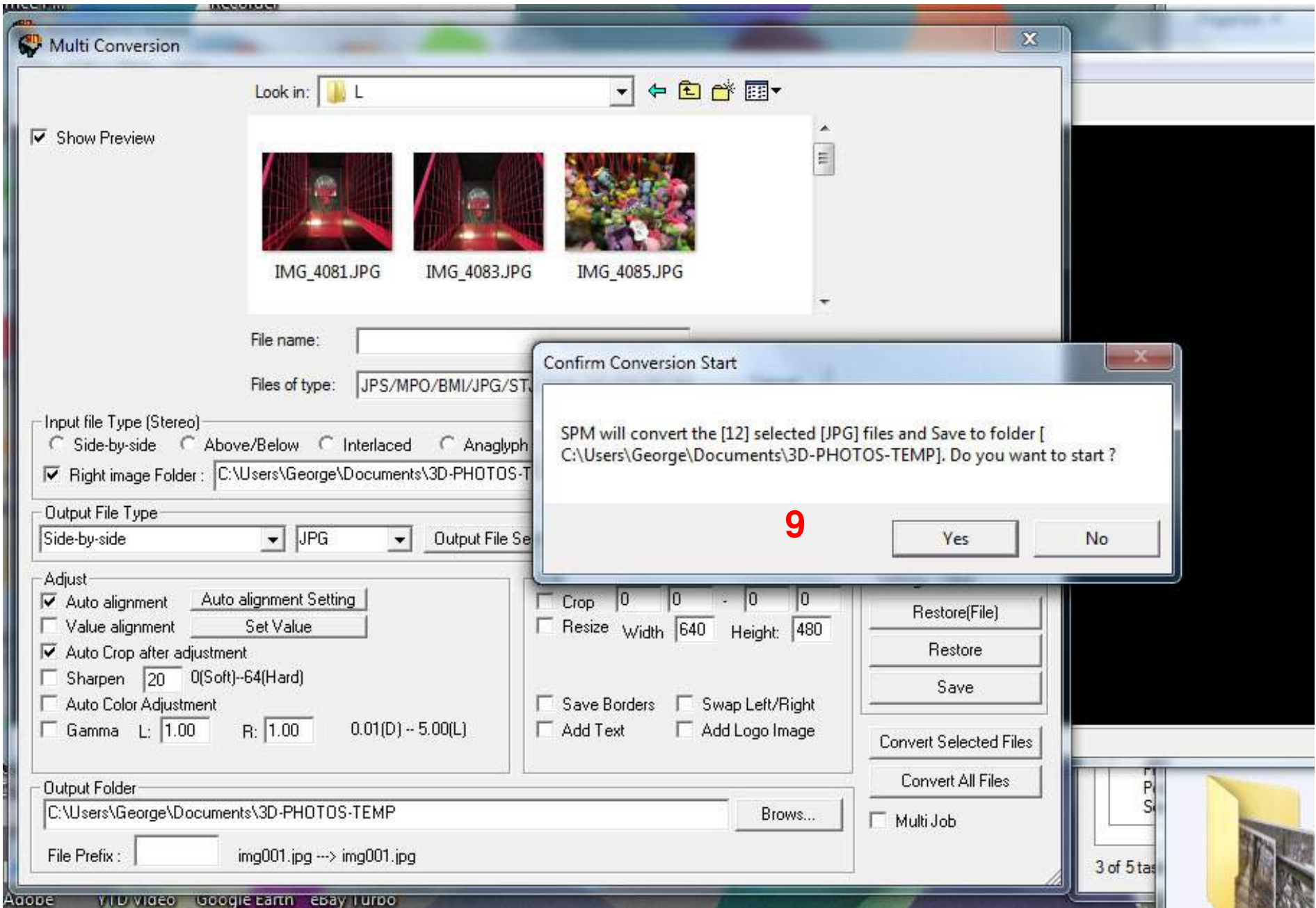
1b

2b

3

2a

4



Confirm Conversion Start

SPM will convert the [12] selected [JPG] files and Save to folder [C:\Users\George\Documents\3D-PHOTOS-TEMP]. Do you want to start ?

9

Yes No

SPM Clone Brush

The SPM Clone brush removes objects from one image (right) and replaces them with whatever is on the other image (left) at the same depth level. It is useful for removing objects that have moved between shots and are distracting. Follow this procedure:

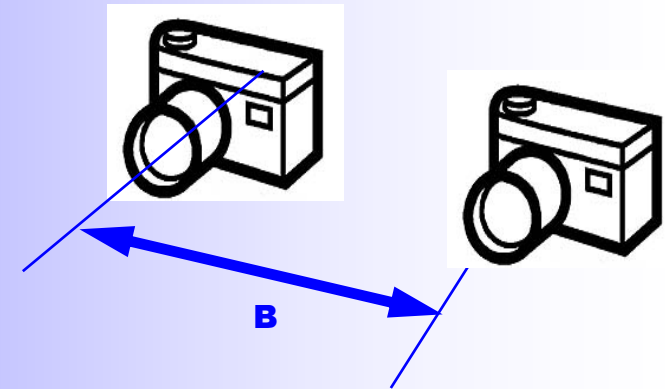
- Make sure that the image you want to change is on the right side (hit X to swap places if needed)
- Press F6 to switch to Gray Anaglyph viewing method
- Superimpose the images using the R/L arrow keys to bring the object to be removed at the window level. Zoom into the working area for a better view (you can do that by using the mouse scroll button)
- Hold the shift button and move the mouse around. Click and hold the left button of the mouse. **Cloning takes place when the shift key and the left mouse button are held both down.** Cloning only affects the red image. Brush over the subject to be removed and it will slowly disappear and be replaced by whatever is on the other image.
- You can control the size of the cloning brush by going under “Edit” and “Clone brush setting” (Shortcut: Ctrl + N)

Sequential 3D Stereo

(+) Inexpensive & readily available

(+) Flexible Stereo Base (B)

(+) Interesting pictures



Today with digital photography & software alignment is the best time ever to experiment with single camera Sequential 3D Photography