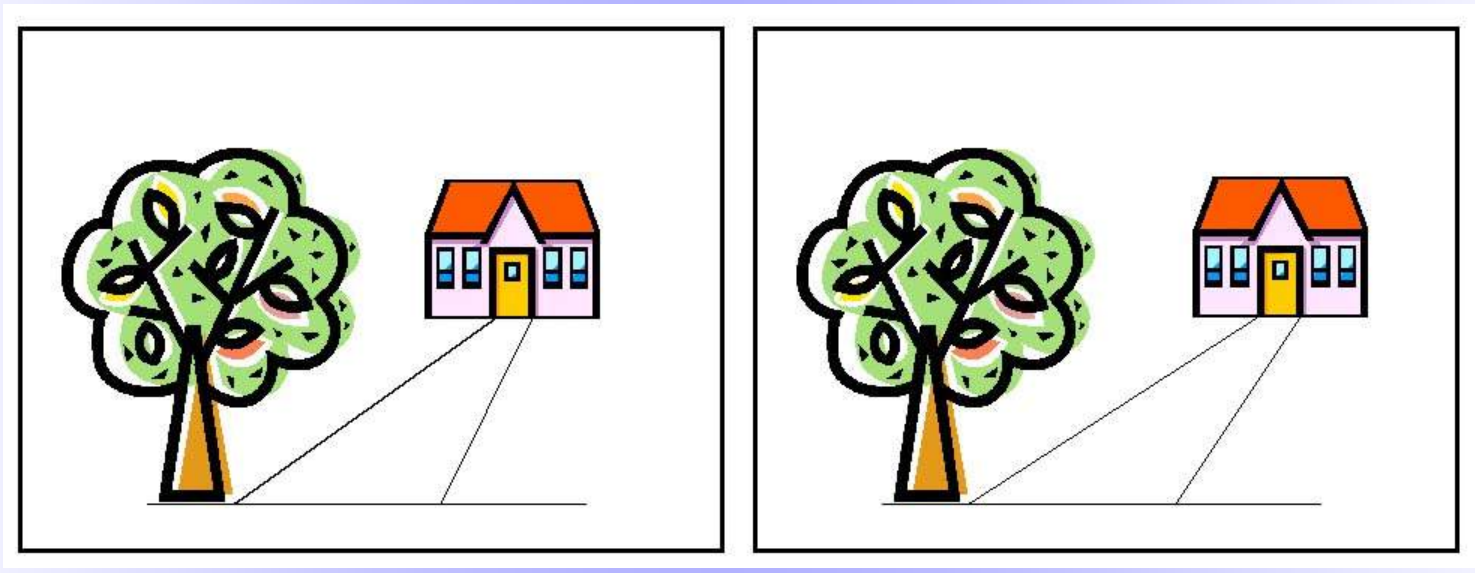
Stereoscopic Deviation



By George Themelis

NSA / ISU - 2019

“Hey, can I have double prints made and then make a stereoview out of them?”


Maximum
Displacement
(Deviation)
CNA
CNA

Stereoscopic Deviations

is what distinguishes 3D pictures from 2D pictures

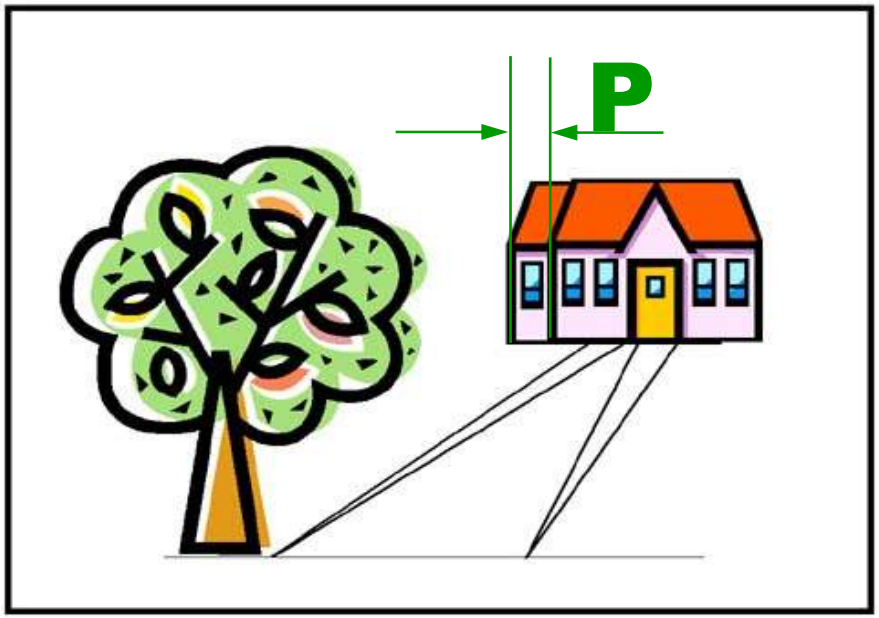
so, it is important to define them and explain what factors affect them

Outline

- What are Stereoscopic Deviations?
- Why are they important?
- How are they created?
- How are they expressed / measured?
- What variables affect them?
- How can they be controlled?
- Do they have an optimum value?
- How much deviation is too much or too little?
- Excessive deviation in 3D projection?
- How can it reduced?

Stereoscopic Deviations

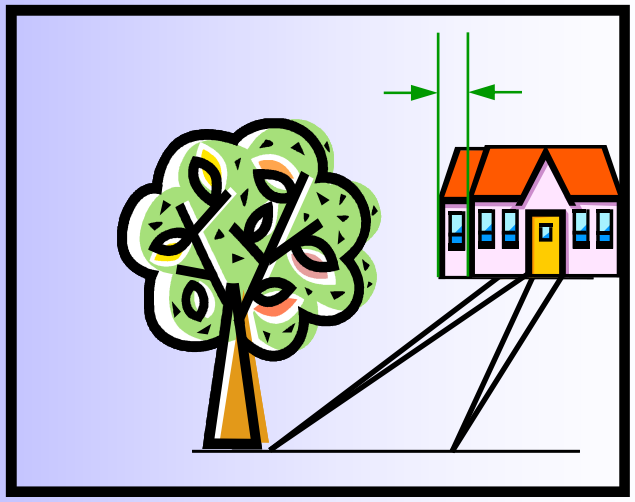
What are they?



- Small displacements in the horizontal direction
- Generated during 3D recording from different point of view
- Can be created artificially (cartoons, 3D conversions, etc.)
- No matter how they are created, the brain converts these displacements to depth

They are the reason we see 3D

How can we measure the Stereoscopic Deviation?



- Back in the slide film days we measured small displacements on tiny film chips

  Today this is much easier, working with **large overlapping images on a computer screen**

- There are several ways to measure the stereoscopic deviation. One way to do it is to use **StereoPhoto Maker** (SPM)

How to measure Deviation using SPM

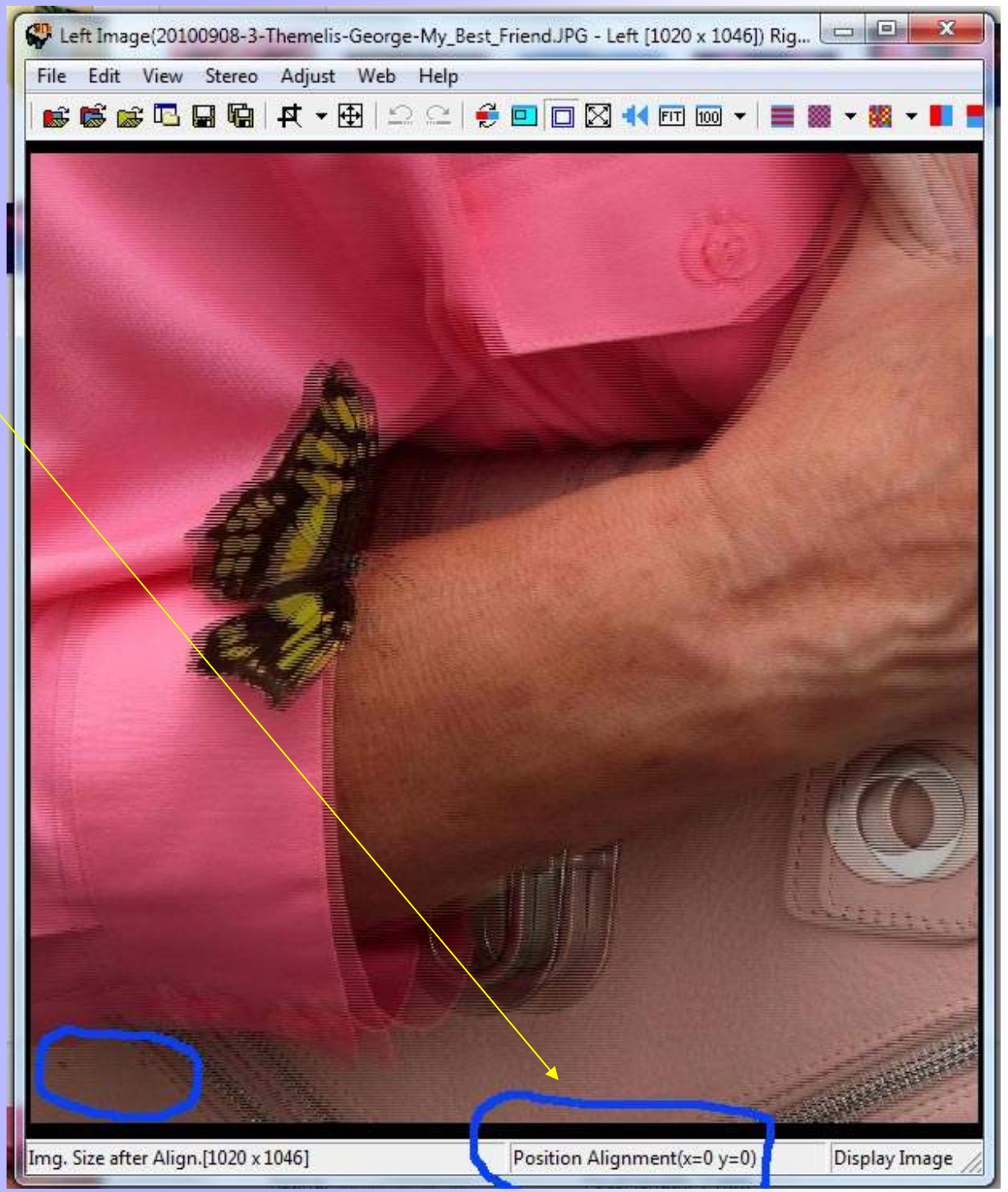
Load the image in SPM

At the bottom of the screen you will see this:
Position Alignment (x=0 y=0)

If you press the arrow keys, these (x, y) numbers will change. Pressing the Right/ Left Arrow keys will increase/decrease x by 4 pixels (default setting).

Put SPM in a **3D viewing mode** (under “Stereo” menu) where the two images overlap.

For most people this will be the Anaglyph mode. If you are using a passive 3D monitor (like I do) select “Interlaced”

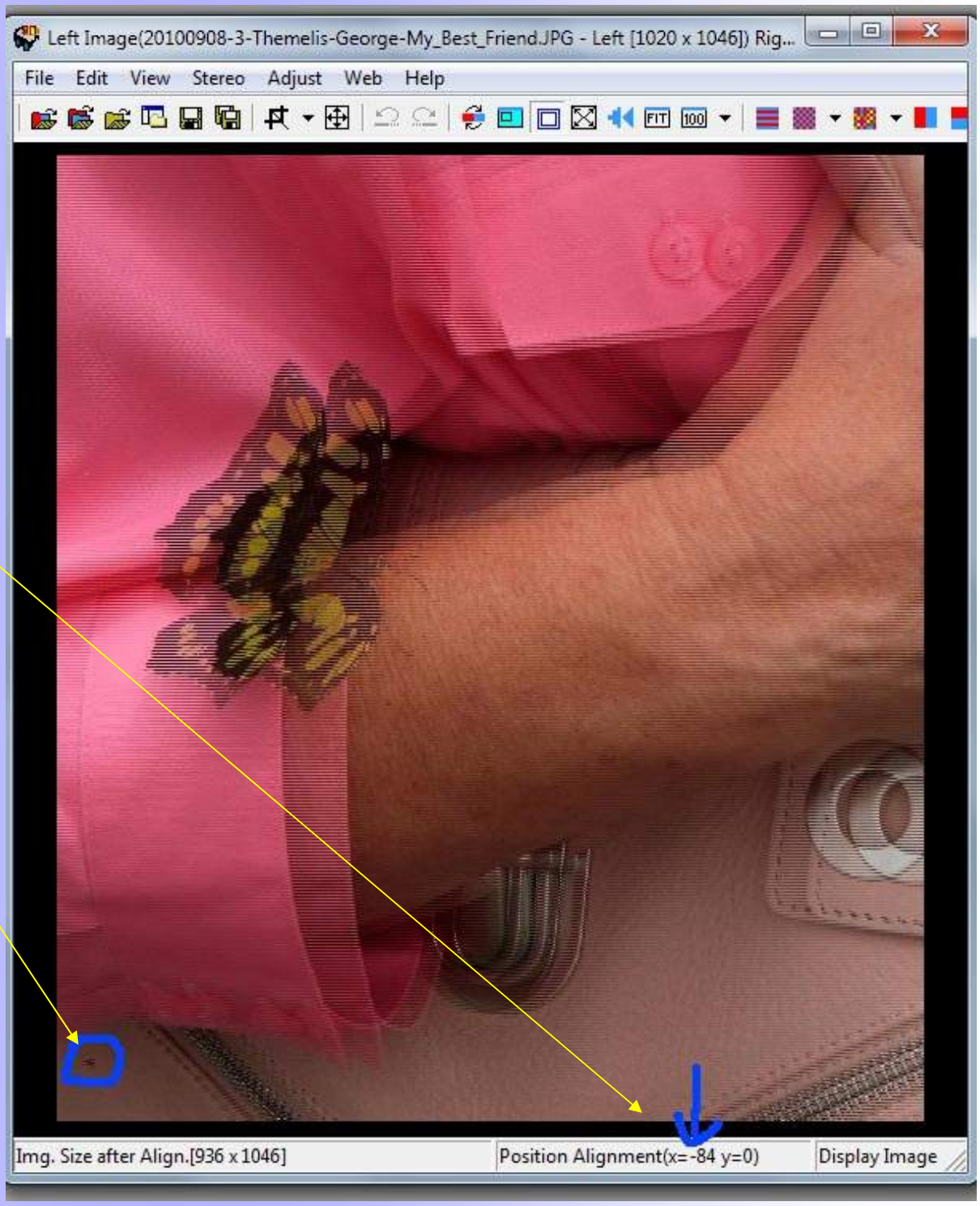


How to measure Deviation using SPM

Press the R & L arrows until different objects of the image overlap on the screen.

As you overlap a certain object, **read the x value**. This is the number of pixels that you had to shift the R and L images to overlap this specific object.

If you are interested in the **maximum deviation**, first observe the image in 3D to see which is the far object, and then press the arrows until it overlaps on the screen. **The x reading is your maximum deviation.**



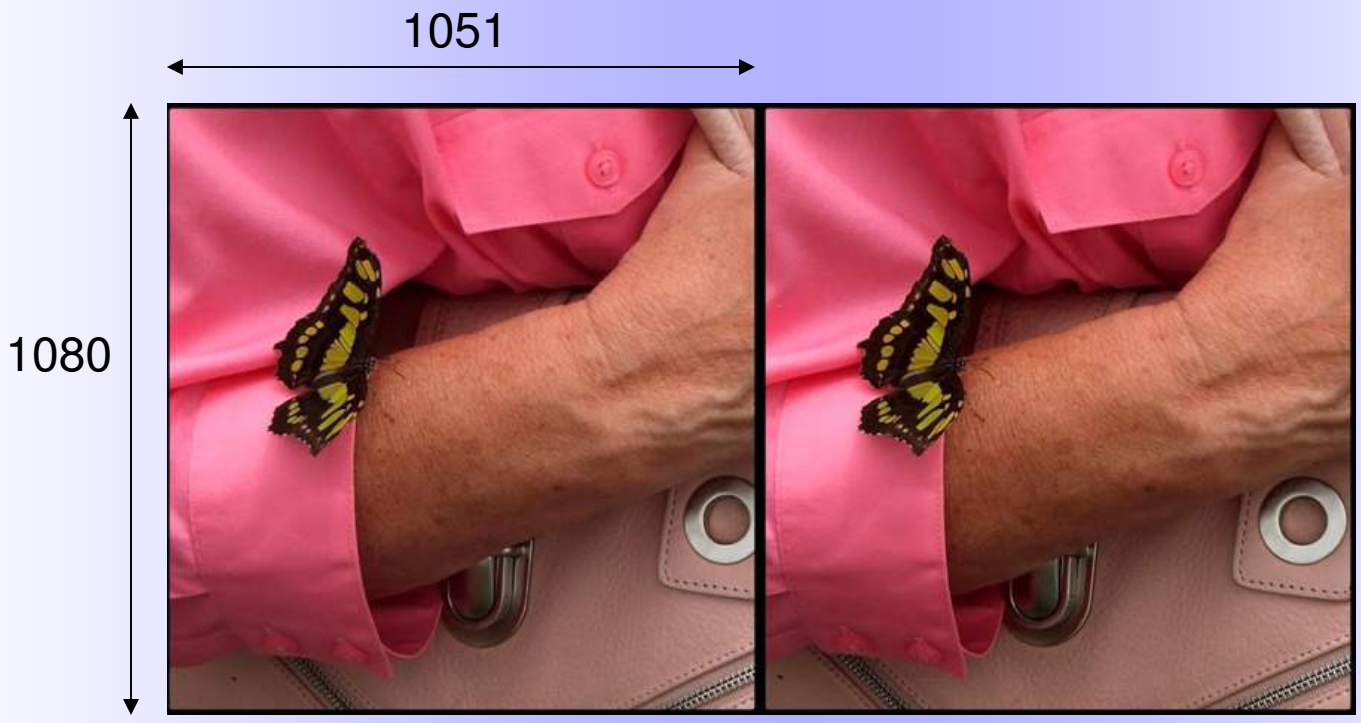


Image size = 2 x 1051 x 1080

Max Deviation = 84 pixels

84/1051 = **8.0%** (1/12)

For Stereo 1920x1080 Projection:

84/1920 = **4.4%** (1/23)

Optimum Stereoscopic Deviation?

There is no optimum - only extremes

Very little depth

Too much depth /deviation

Maximum depends on the viewing method

Even within the same general viewing method (projection for example) the maximum might change (depending on the size of the screen)

For general 3D photography 3% is recommended

3% (1/30) works well for stereo projection on a medium sized screen

For large screens it is better to be conservative (2% or 1/50 is better)

Stereoscopic Deviations

On-screen deviation

Deviation		*Screen Size*		
		Small	*Club*	*NSA*
Ratio	%	20 in (0.5m)	80 in (2m)	190 in (4.8m)
1/50	2.0	0.40	1.60	3.80
1/30	3.3	0.66	2.64	6.27
1/25	4.0	0.80	3.20	7.60

- Spacing of eyes 2.5 inches (65mm)
- Anything larger than 2.5 inches causes divergence
- A small amount of divergence is tolerated

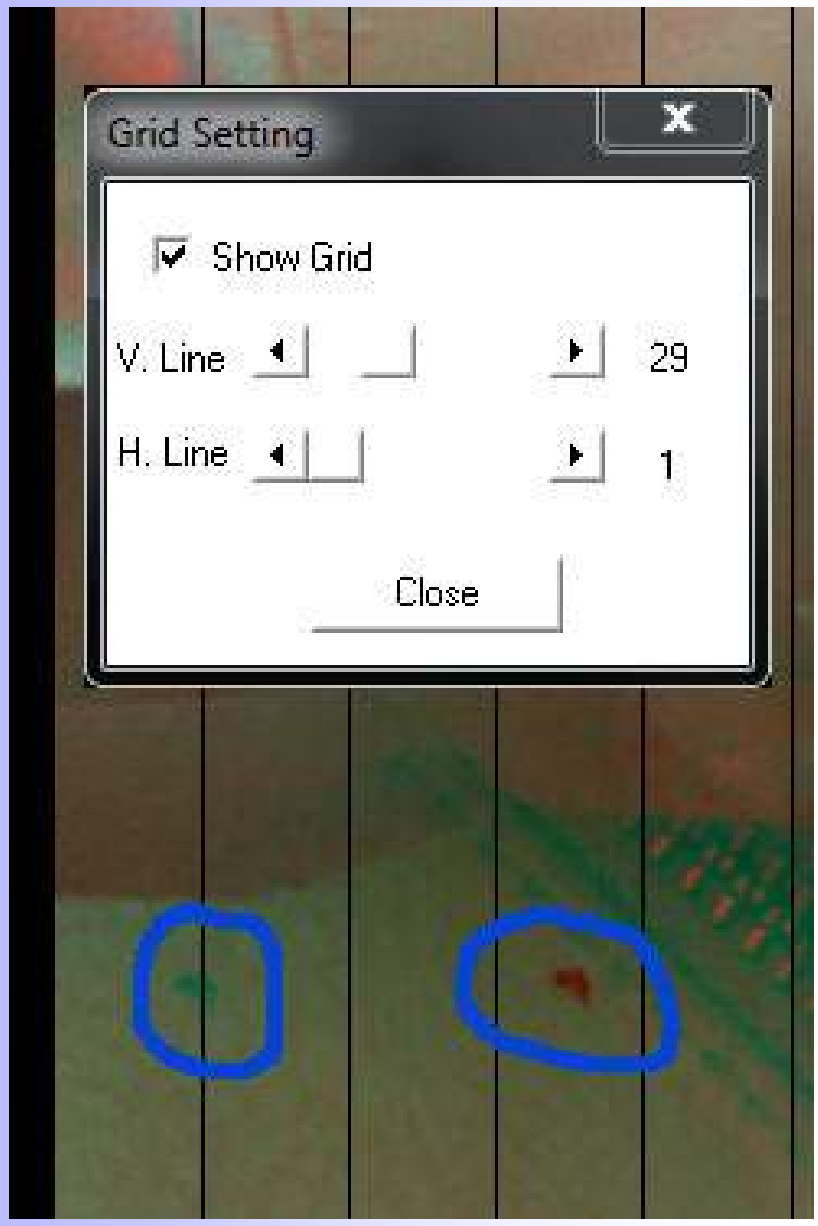
2nd method - Using a Grid in SPM

Dennis Green (of the Detroit Stereo Club) made me aware of this method. First, go to anaglyph (or interlaced) mode to overlap the two images.

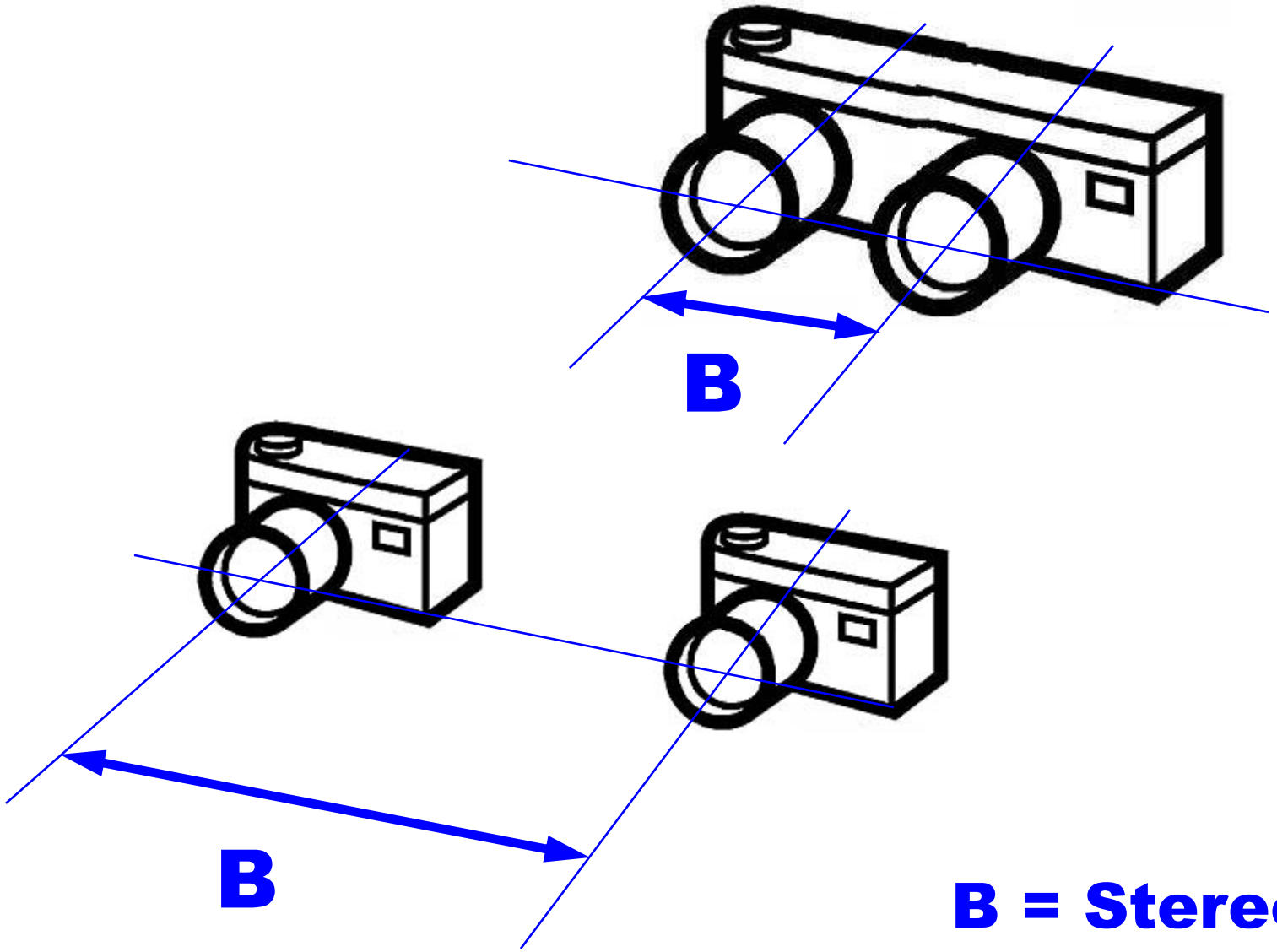
Then go to View -> Grid Setting (bottom of the menu). **Set the V Line to 29** (this will divide the image to 30 segments).

With just one look you can see which points are within one segment so have **the maximum recommended deviation** (1/30) or less

For the maximum deviation this method gives a value of 2.5 times the recommended value (2.5/30 = 1/12)



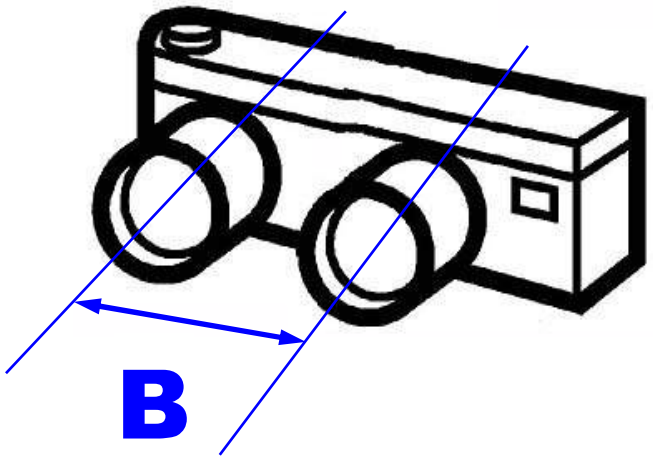
How are Stereoscopic Deviations created?

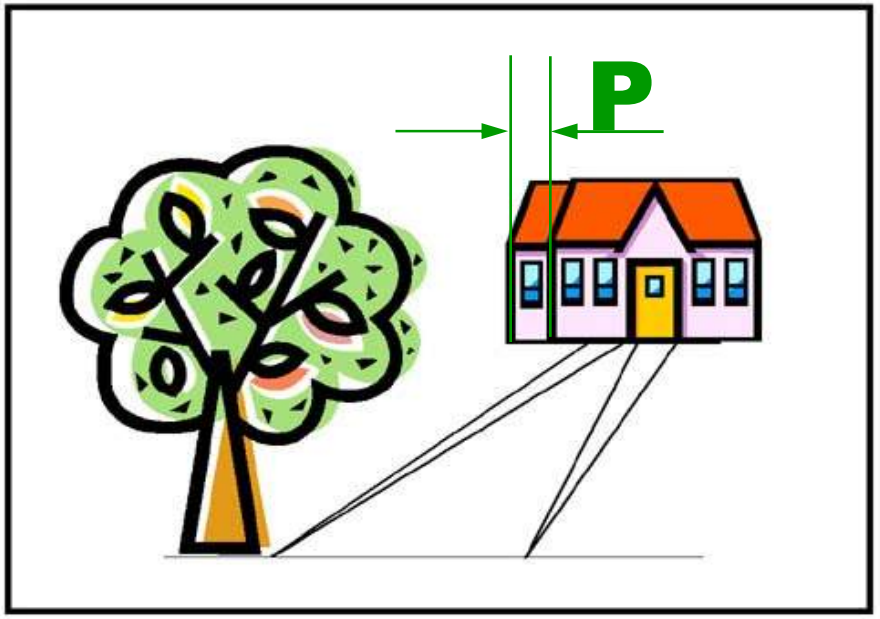


B = Stereo base

Variables that Affect Stereoscopic Deviation

$$P = FB/I = MB$$





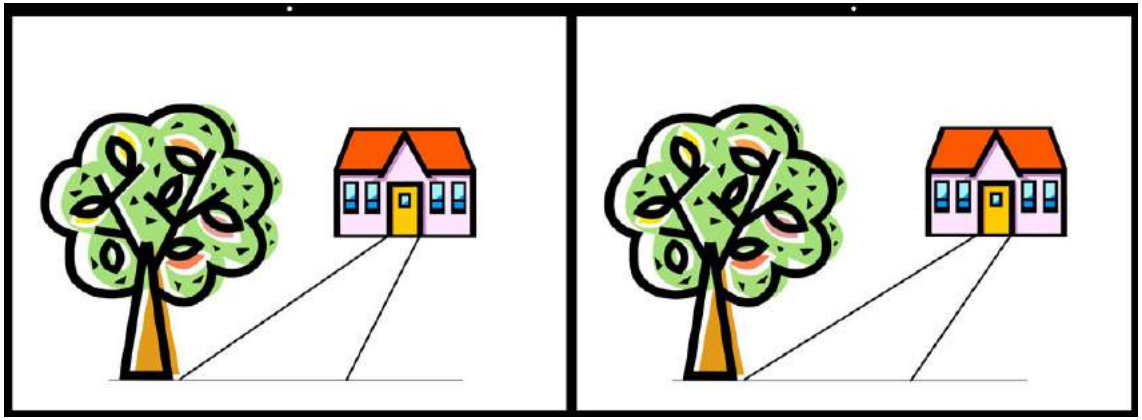
Stereoscopic Deviation & The Stereo Window

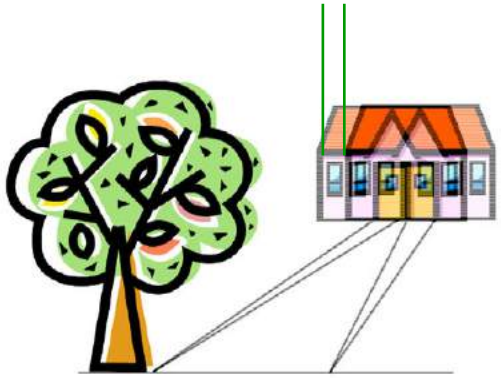
We can distinguish two kinds of maximum deviation:

Maximum stereoscopic deviation in the
as recorded stereo pair (from near to far object)

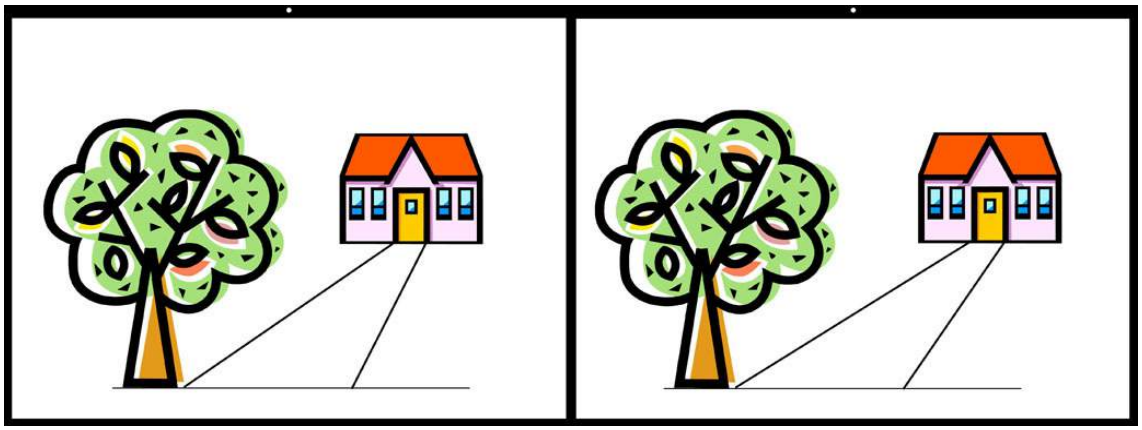
Maximum stereoscopic deviation in the
as-mounted stereo pair

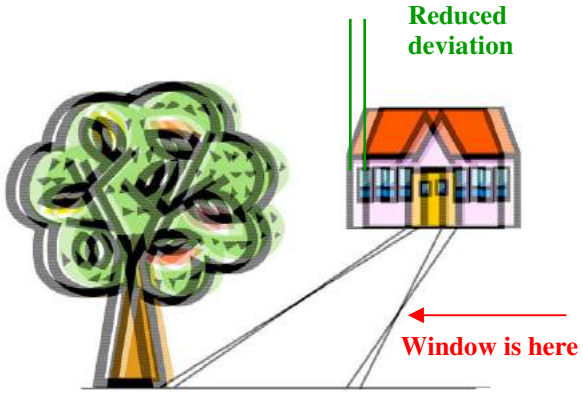
These can be different, depending on how the stereo window is set



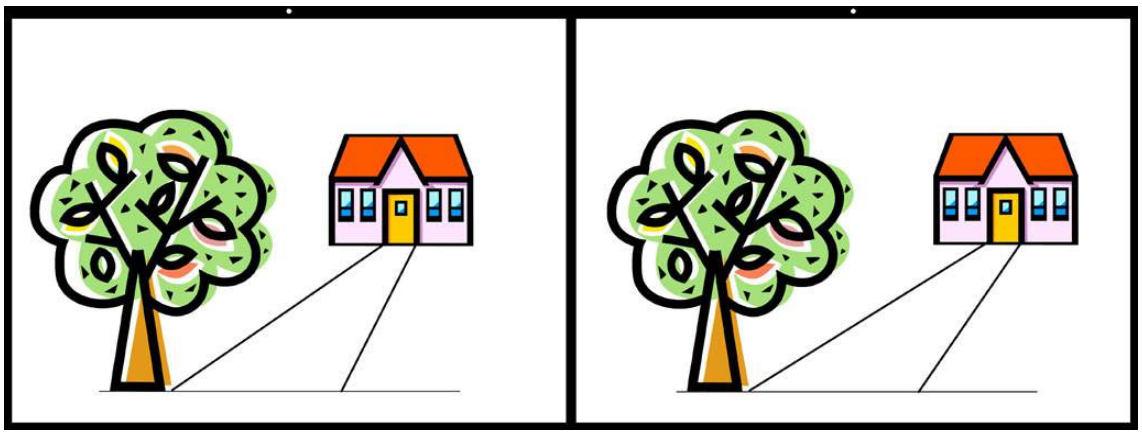


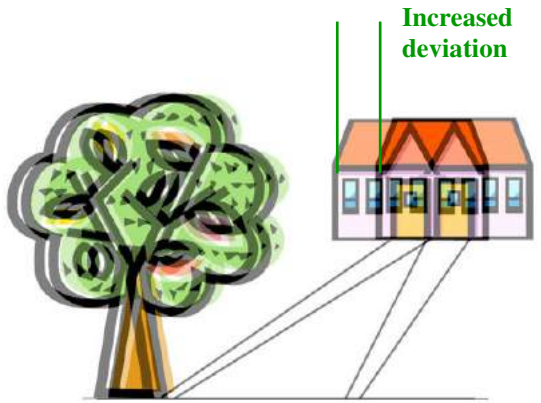
a) Tree at window level





b) Tree in front of the window (house behind)





c) Tree (everything) behind the window

Case Study

Ghosting in 3D Projection

Ghosting ("cross-talk"): **Part of the right image is seen by the left eye and part of the left image is seen by the right eye**, so the image looks like a ghost.

Ghosting in polarized 3D projection is the result of **incomplete polarization**

Ghosting depends on the **image contrast** and on the **separation of the objects on the screen**. Objects at "screen or window level" coincide fully and do not ghost at all.

A bright object next to a dark object at infinity is the worst possible combination. Large deviation = more ghosting, small deviation = less ghosting

Excessive Deviation

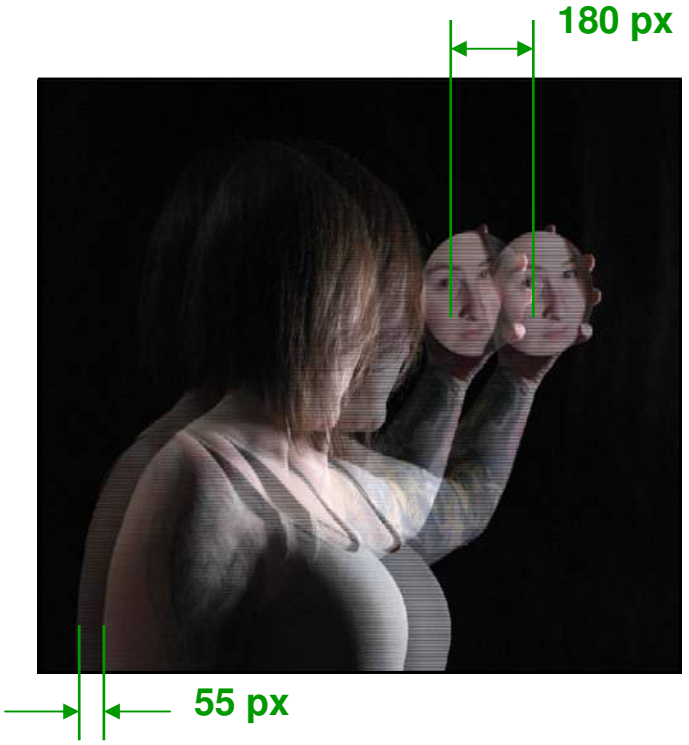
In addition to being hard to fuse

also leads to ghosting in projection

Deviation: 180/1920 = 9.3%
(about 3x the recommended 3%)

On our club's 80 inch screen the on-screen deviation is ~6.5 inches, which is excessive

Furthermore, because the distant object is bright against a totally dark background, this image shows a lot of ghosting.



What could have been done to improve this image?

1. Record it with less deviation

Because this is a staged shot, the photographer could have:

1) used a camera with a smaller stereo base

2) moved back and zoomed in (or cropped)

What could have been done to improve this image?

Even with the amount of deviation recorded, the picture could have been aligned differently to minimize on-screen deviation. The first step is to:

Put the near object at the window level

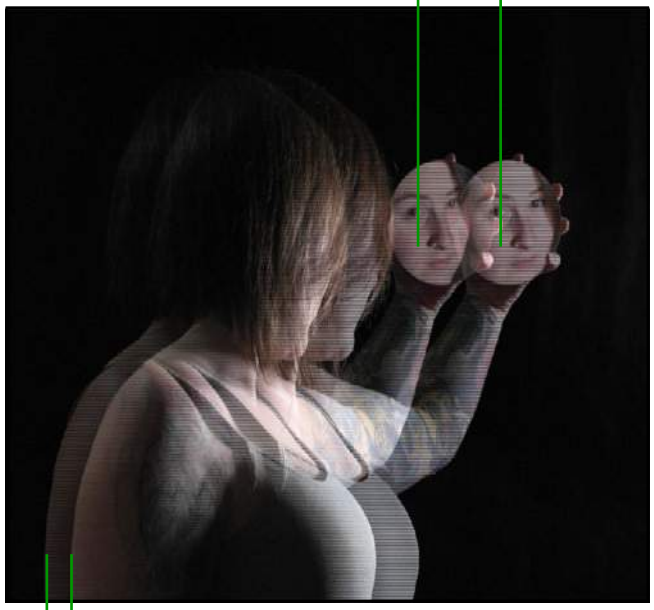
This would remove the 55 pixels, the gap between the window and the near object. The deviation would have been 180-55 = 125 pixels (**6.5%**, still too large but now ~2x instead of 3x).

The image could have been **pushed through the window**

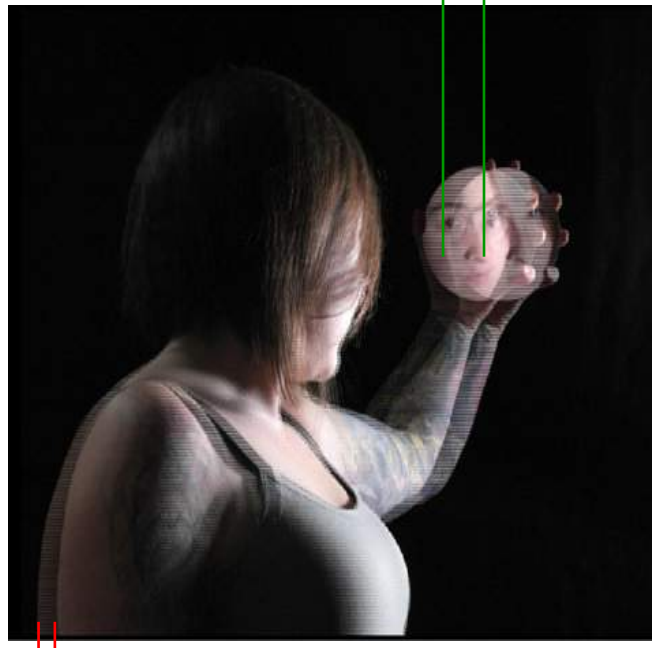
to reduce the deviation further. There will be a “window violation” but because this is confined to the bottom of the screen, it is not as severe as a side violation and, in my opinion, it is preferable to excessive on-screen deviation and ghosting.

This is exactly what SPM does with auto-alignment under the default settings

Original Image



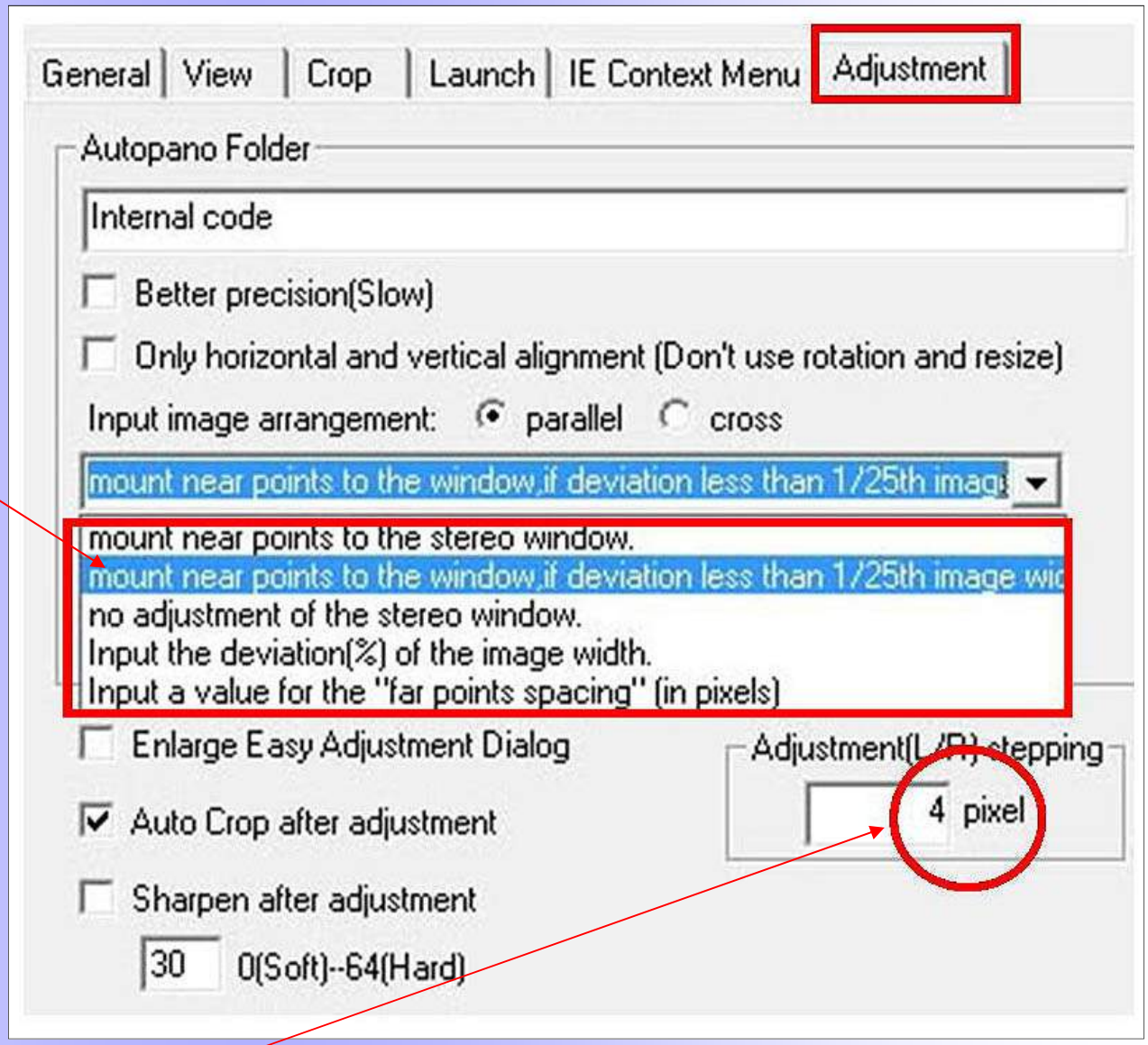
After SPM Alignment (92 px horizontal shift)



During autoalignment (Alt <A>), SPM will adjust the horizontal spacing (**stereo window**) according to the “Preferences”. If you have not changed the default settings, and you **notice a window violation** after alignment, then that’s also a warning that the image has too much deviation.

I recommend using **SPM autoalignment under the default settings** and studying the report that pops up. This warns of any potential excessive deviation issues.

The only thing I have changed is the step from 4 pixels to 10. This is the step each time you press the arrow keys. **By holding the shift key, the step is 1 pixel.**



Three Ways to Minimize Deviation

For comfortable Stereo Projection

During Recording

During Alignment

During Projection

How to Minimize Deviation - While Shooting - I

1) Do not come too close to the near object

A rule of thumb is that the near object should be no closer than 30x the distance of the lenses, if infinity is in the picture. For the Fuji camera (B = 70mm) this comes to 2.2m (about 7 feet). For the Panasonic 3D1 camera (B = 30mm) this comes to 0.9m (3 feet). You can come closer to the near object if there is no distant background in the picture.

2) Switch to a camera with a shorter lens spacing

For example, switch from the Fuji to the Panasonic 3D1. Stereoscopic deviation is proportional to the distance of the lenses (stereo base, B).

How to Minimize Deviation - While Shooting - II

3) Avoid distant background in close-ups

- Change your angle of view
- Use artificial background (black cloth or colored construction paper, for macros)
- Use flash (will turn the background dark) to minimize the background

Here are some tricks that I use when I shoot macros:

1) Shoot against the (featureless) sky. Also, shoot facing down so the ground is the background.
2) Hold the (small) object in my hands (this also adds a scale, in addition to blocking the background)
3) Use flash to darken the background

How to Minimize Deviation - While Shooting - III

4) Measure or calculate the deviation to make sure it is not excessive

When taking single camera **hyperstereos**, an easy solution for me is to use my phone as the camera or as a measuring tool:

Take a picture and have the iStereoid app calculate the deviation. **I aim for 1-3%** (2% is a good choice, 1.5% is fine too). If I want to use a different camera, I take the picture using the same stereo base.

Smartphone Apps

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

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). **I recommend 1.5-2%**

How to Minimize Deviation - In Post Processing

Measure the deviation. If this is excessive (>3%) then:

1) Crop the image to remove near or distant objects

Note however that cropping will also increase the overall deviation when resizing to the same image size (increasing the magnification), so be careful with cropping

2) Optimize stereo window placement

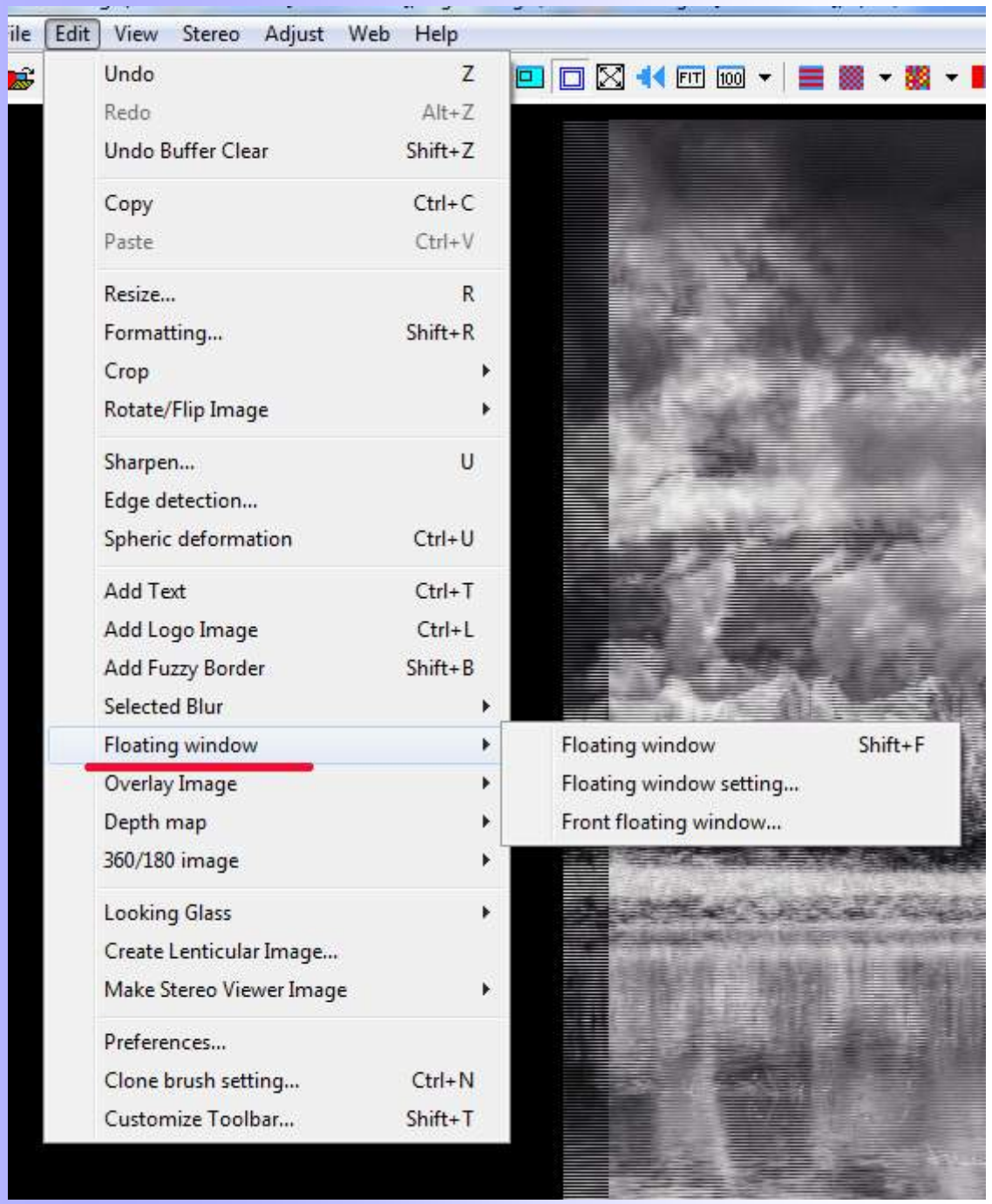
Place the near object at the stereo window or push through the window to minimize the deviation of the background. Try to avoid window violations but remember that top/bottom violations are preferable to side violations.

Floating Window

There is a technique called "**floating window**" where the stereo window is placed in front of the screen. This reduces the deviation without violating the window.

Two ways to do this:

- Use the SPM function
- Use black borders



How to Minimize Deviation - In Post Processing

3) Reduce the overall size of the image. This can be done by putting black borders at the top/bottom and sides. Reducing the size reduces the deviation proportionally. The drawback of this method is that the image will look smaller in projection. Still, this can be a valid method to salvage an interesting image.

4) Remove the background or reduce the deviation with software. Maybe one day there will be an easy to use program that will adjust the stereo image to reduce the deviation, as if it was recorded with a shorter stereo base.

How to Minimize Deviation - in Projection

- Usually, stereo projection is set with the **stereo window coinciding with the projection screen**
- But, for large screen projection, some projectionists **set the stereo window in front of the screen**
- **This is similar to the "floating window"** (essentially, the projection setup puts the same "floating window" on all images) and it will reduce the on-screen deviation
- Some issues with this is that it does not work with single 3D projectors or with projectors that do not have lateral lens shift.
- I have no experience with this and I understand that it is not used at NSA or our club, but it has been used at ISU