An Introduction to Making Phantograms

By

Steve Hughes

NSA 2004 July 7 –12, 2004

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What is a “Phantogram”?

- A stereo image that appears to be at an angle to the plane of the surface it is rendered on
- Any angle of view and perceived image plane is possible
- We will discuss images that seem to “float” above the surface

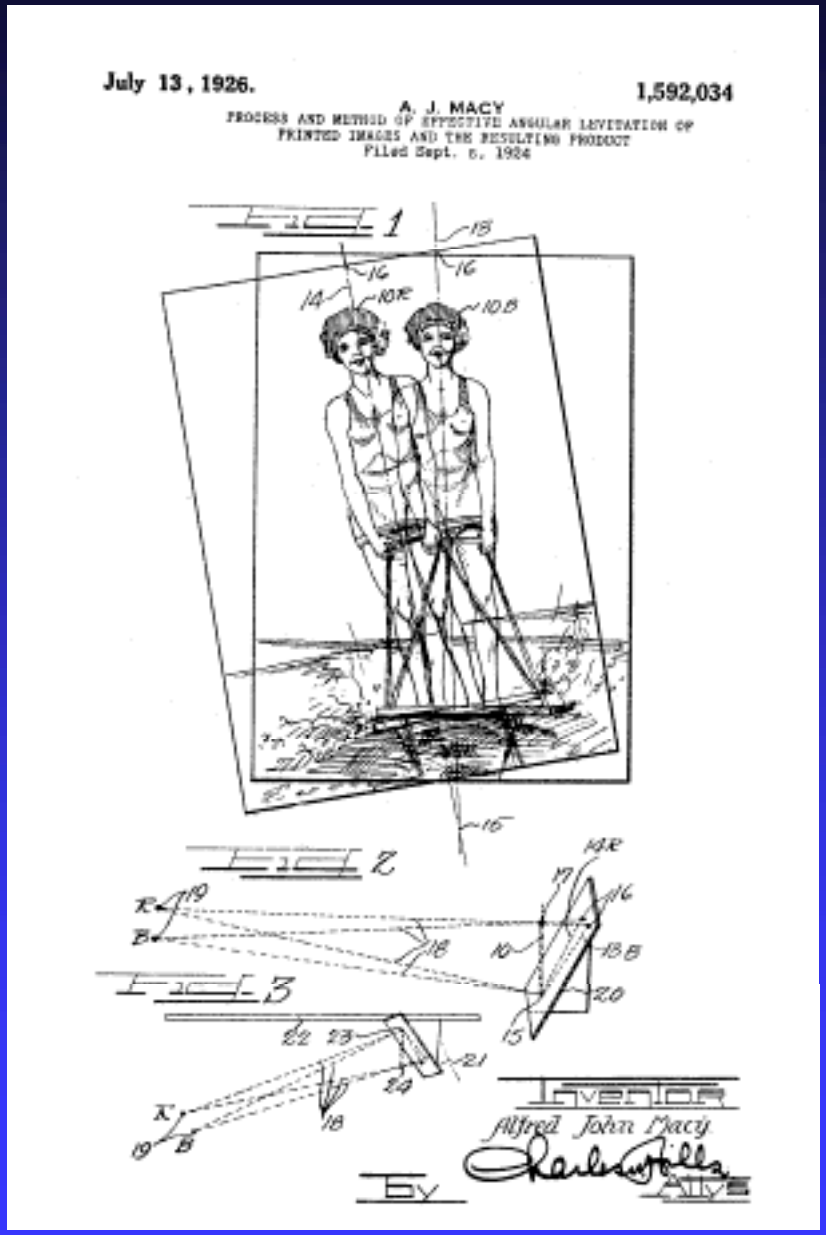
Why “Phantogram”?

- Aladar Heppes name for this type of image
- Also called “Stereoscopic anamorphsises”, “Phantaglyphs®”, “Free standing anaglyphs”, “Levitated images”,”Book anaglyphs”
- “Phantogram” appears to be in public domain

Some History

- Used in Descriptive Geometry texts
- “How-to” book by Raymond Nicyper in 1979 “Constructing anaglyph images on Phantogram Perspective Charts”
- Commercial art by Achim Bahr in 1981
- Commercial photos by Boris Starosta in 1998

A.J. Macy 1926 Patent



July 13, 1926. 1,592,034

A. J. MACY

PROCESS AND METHOD OF EFFECTIVE ANGULAR LEVITATION OF PRINTED IMAGES AND THE RESULTING PRODUCT

Filed Sept. 5, 1924

FIG. 1

FIG. 2

FIG. 3

Inventor

Alfred John Macy

By

Atty

Western 2002 Patent

(12) **United States Patent**
Western

(10) **Patent No.: US 6,389,236 B1**
(45) **Date of Patent: May 14, 2002**

(54) **ANAGLYPH AND METHOD**

(76) Inventor: **Owen C. Western**, 6274 Lake Apopka Pl., San Diego, CA (US) 92119-3521

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/495,721**

(22) Filed: **Feb. 1, 2000**

(51) **Int. Cl.**[7] **G03B 35/00**
(52) **U.S. Cl.** **396/324**; 355/22
(58) **Field of Search** 355/22; 396/322, 396/324, 325, 329, 333

(56) **References Cited**

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6,037,971 A * 3/2000 McLaine et al. 348/47

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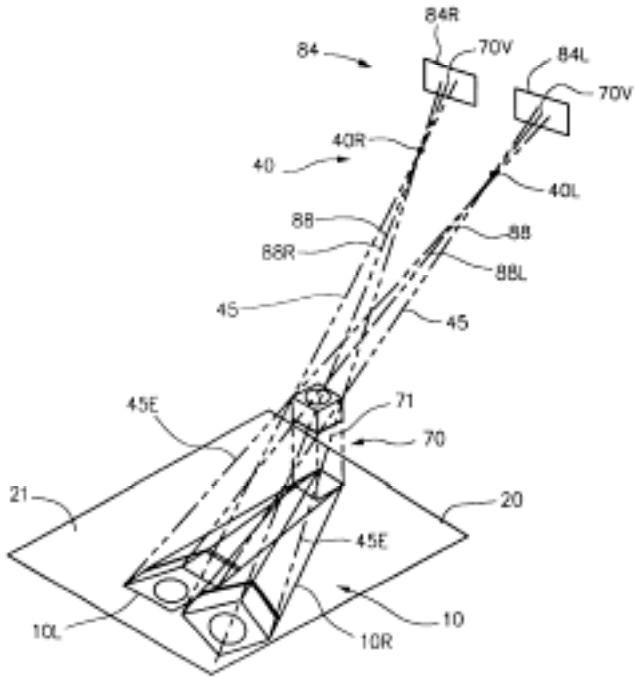
Primary Examiner—David M. Gray
(74) *Attorney, Agent, or Firm*—Calif Tervo

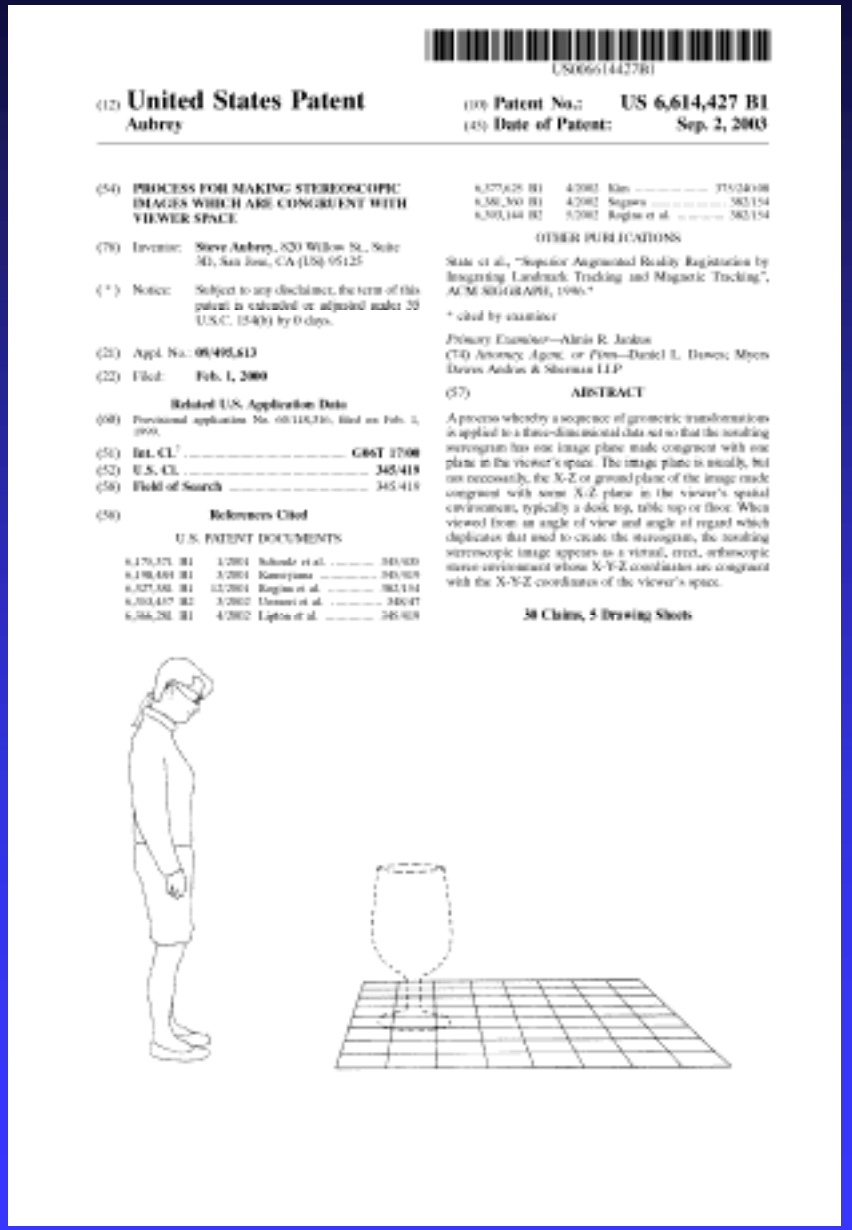
(57) **ABSTRACT**

The method of making the anaglyph on a page of an object comprises the steps of: producing left and right stereoscopic views of the object; and then, producing a left anaglyph image adding a first color on a planar page as a projection or equivalent to a projection of the left view on the page the page being vertically angled to the left image plane; and producing a right anaglyph image adding a contrasting color on the page as a projection or equivalent to a projection of the right view on the page. The perspective plane lies in the plane of the surface. Retinal rivalry is reduced by muting (desaturating) the original anaglyph colors to a color image of the object before adding the colors for the anaglyph.

6 Claims, 2 Drawing Sheets



Aubrey 2003 Patent



US006614427B1

(12) **United States Patent**
Aubrey

(10) **Patent No.: US 6,614,427 B1**
(45) **Date of Patent: Sep. 2, 2003**

(54) **PROCESS FOR MAKING STEREOSCOPIC IMAGES WHICH ARE CONGRUENT WITH VIEWER SPACE**

(76) Inventor: **Steve Aubrey**, 820 Willow St., Suite 3D, San Jose, CA (US) 95125

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/495,613**

(22) Filed: **Feb. 1, 2000**

Related U.S. Application Data

(60) Provisional application No. 60/118,316, filed on Feb. 1, 1999.

(51) **Int. Cl.**[7] **G06T 17/00**

(52) **U.S. Cl.** **345/419**

(58) **Field of Search** 345/419

(56) **References Cited**

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State et al., "Superior Augmented Reality Registration by Integrating Landmark Tracking and Magnetic Tracking", ACM SIGGRAPH, 1996.*

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Primary Examiner—Almis R. Jankus
(74) *Attorney, Agent, or Firm*—Daniel L. Dawes; Myers Dawes Andras & Sherman LLP

(57) **ABSTRACT**

A process whereby a sequence of geometric transformations is applied to a three-dimensional data set so that the resulting stereogram has one image plane made congruent with one plane in the viewer's space. The image plane is usually, but not necessarily, the X-Z or ground plane of the image made congruent with some X-Z plane in the viewer's spatial environment, typically a desk top, table top or floor. When viewed from an angle of view and angle of regard which duplicates that used to create the stereogram, the resulting stereoscopic image appears as a virtual, erect, orthoscopic stereo environment whose X-Y-Z coordinates are congruent with the X-Y-Z coordinates of the viewer's space.

30 Claims, 5 Drawing Sheets

Patents

- Patents may be viewed at the Patent Office web site: http://www.uspto.gov/
- Macy 1926 #1,592,034
- Western 2002 #6,389,236
- Aubrey 2003 #6,614,427
- If you are planning any commercial use of Phantograms I advise talking to a patent lawyer

More History

- My research shows that many people have made Phantograms over the years
- I’m always looking for more examples
- Let me know at steve@shughes.com

Viewing Phantograms

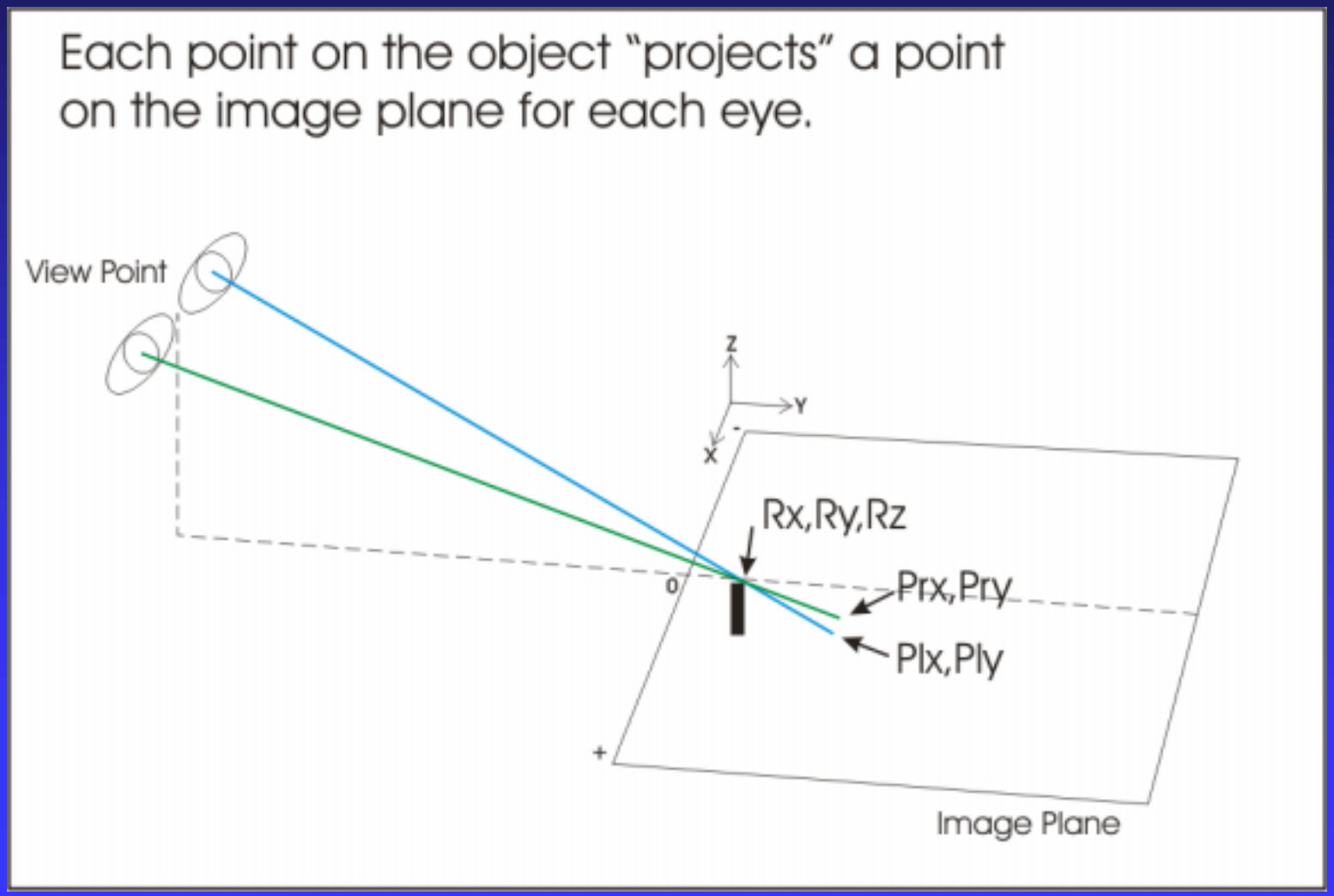
- These images are designed to be viewed at a certain height and distance from the image
- If viewed at any other height or distance the image will look distorted
- If properly done, you can take measurements off the virtual image

Drawing Phantograms

- Drawings are pretty simple if tedious
- Simple formulas may be used to map real world objects to image space
- You can check photographic Phantograms using the formulas
- Lets work through defining the formulas
- To keep it simple, we will do “X” and “Y” individually

Projection of Image Points

Each point on the object "projects" a point on the image plane for each eye.

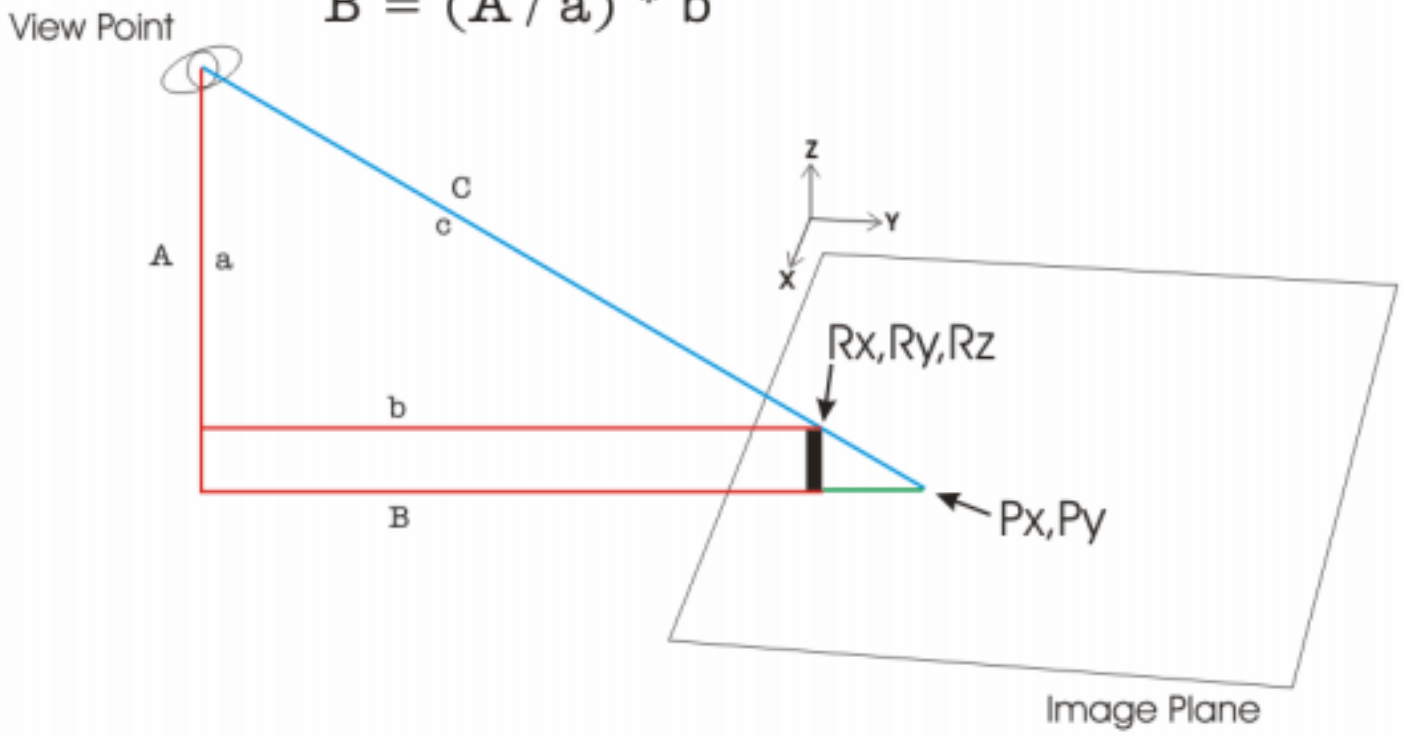


“Y” Is The Same for Both Points

We can find the “y” value using the similarity of triangles.

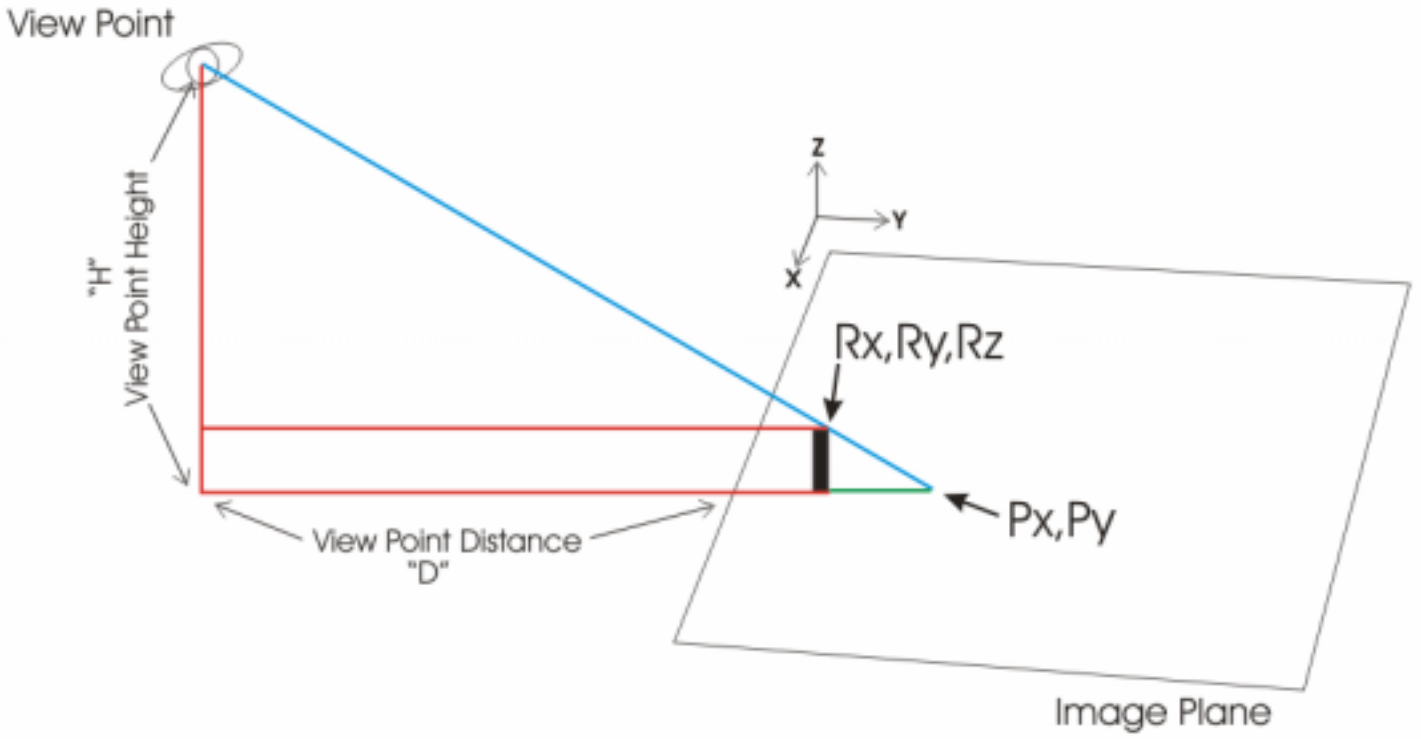
$$A / B = a / b$$

$$B = (A / a) * b$$

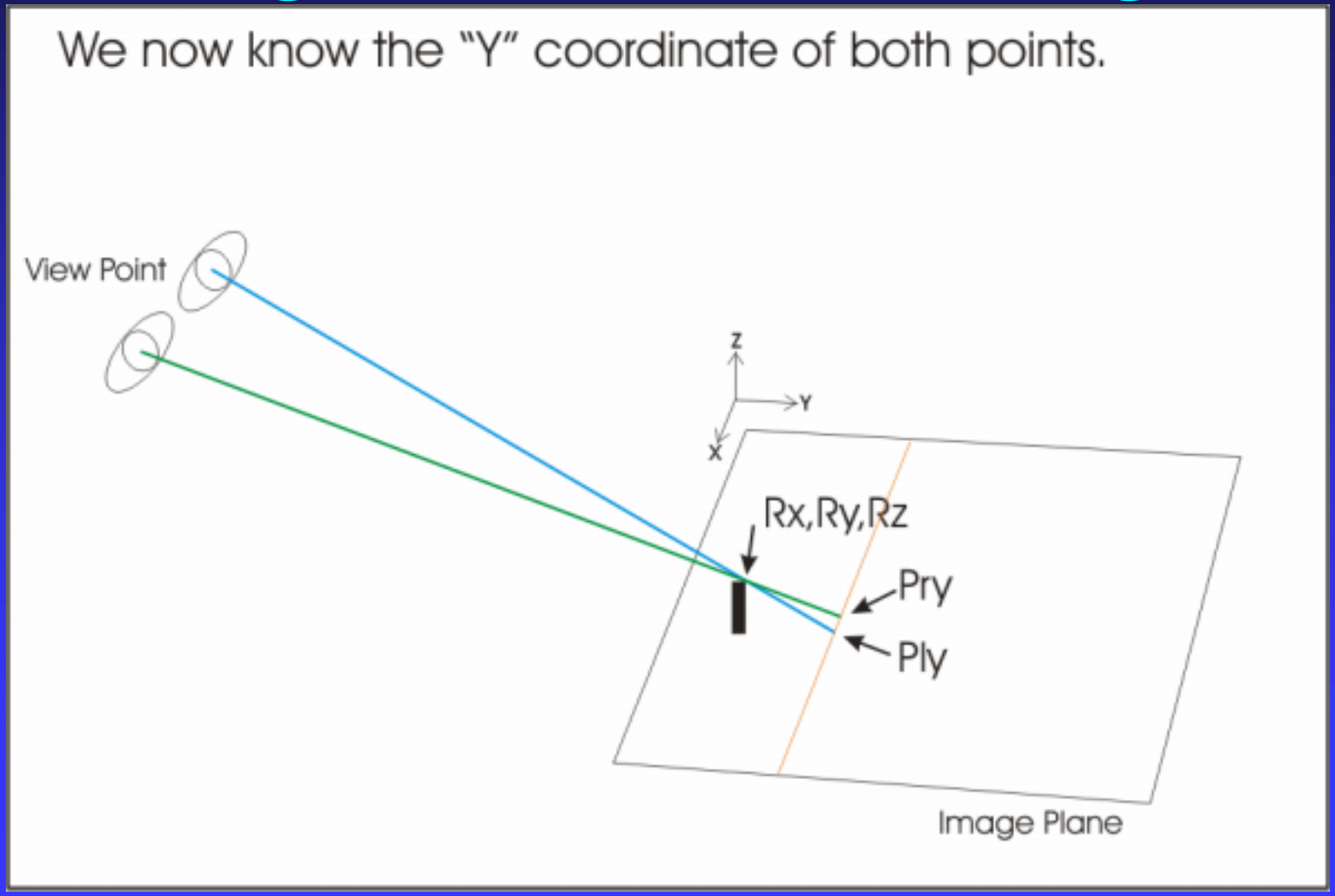


A Practical Formula

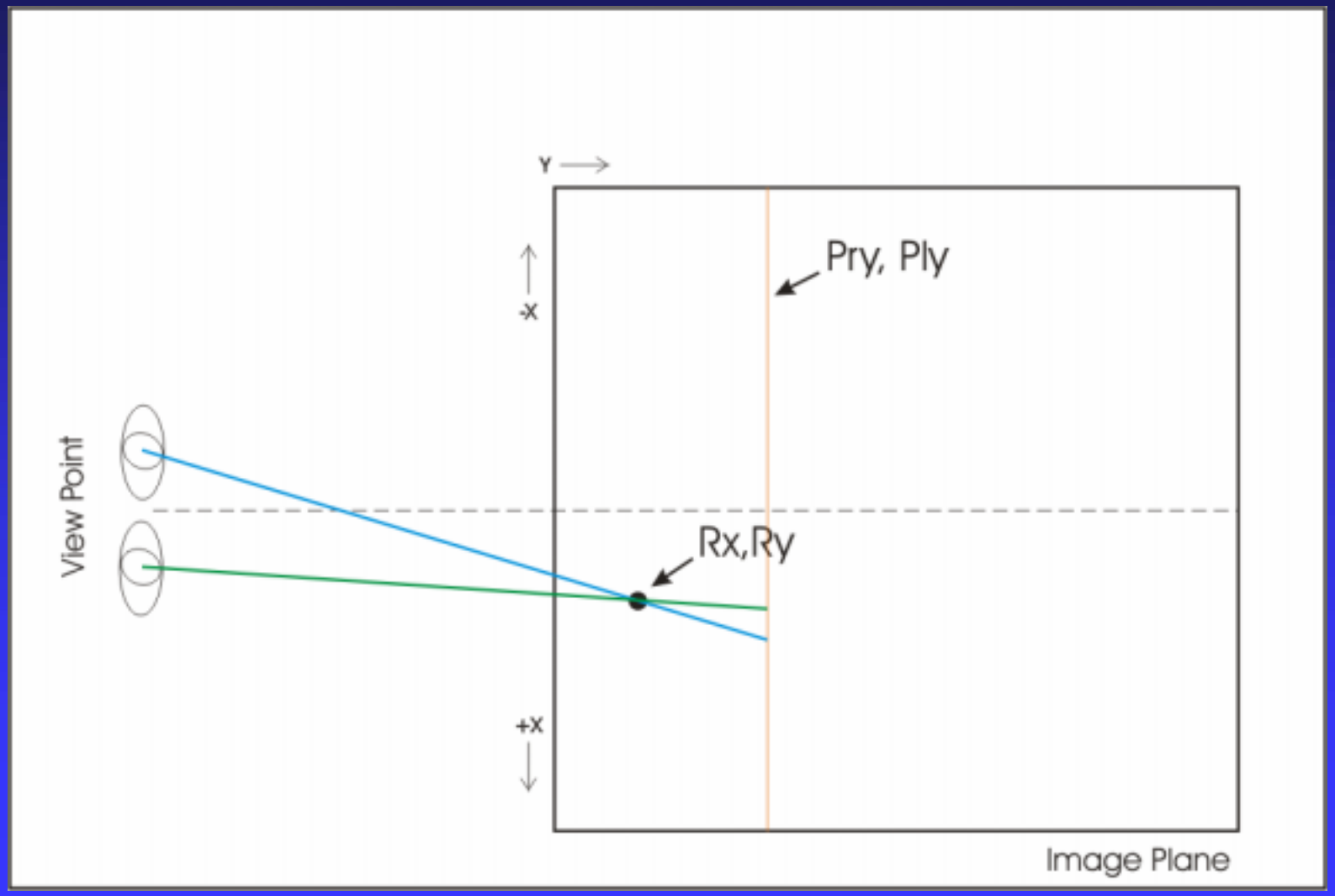
$$Py = ((H / (H-Rz))*(D+Ry))-D$$



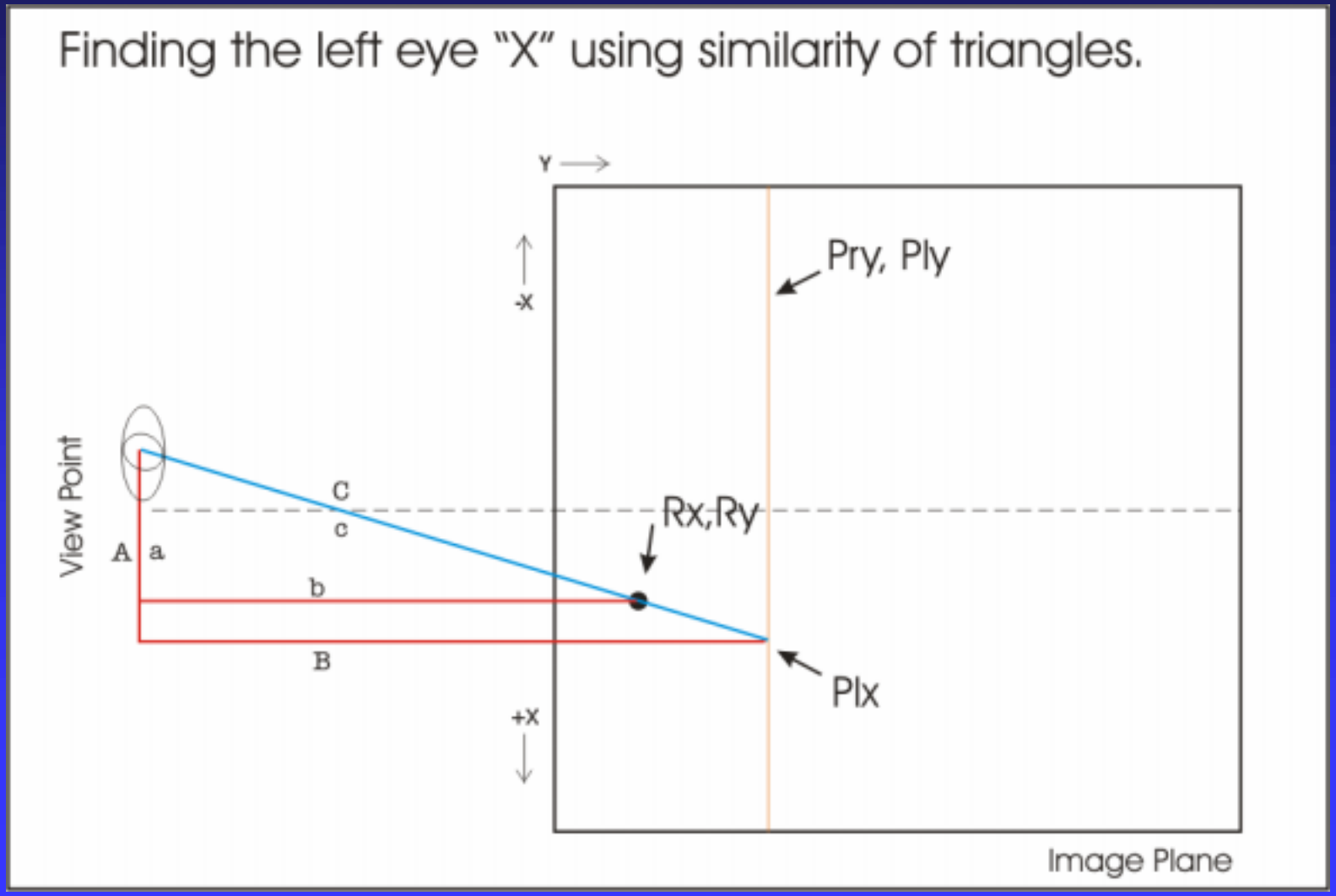
Finding “X Left” and “X Right”



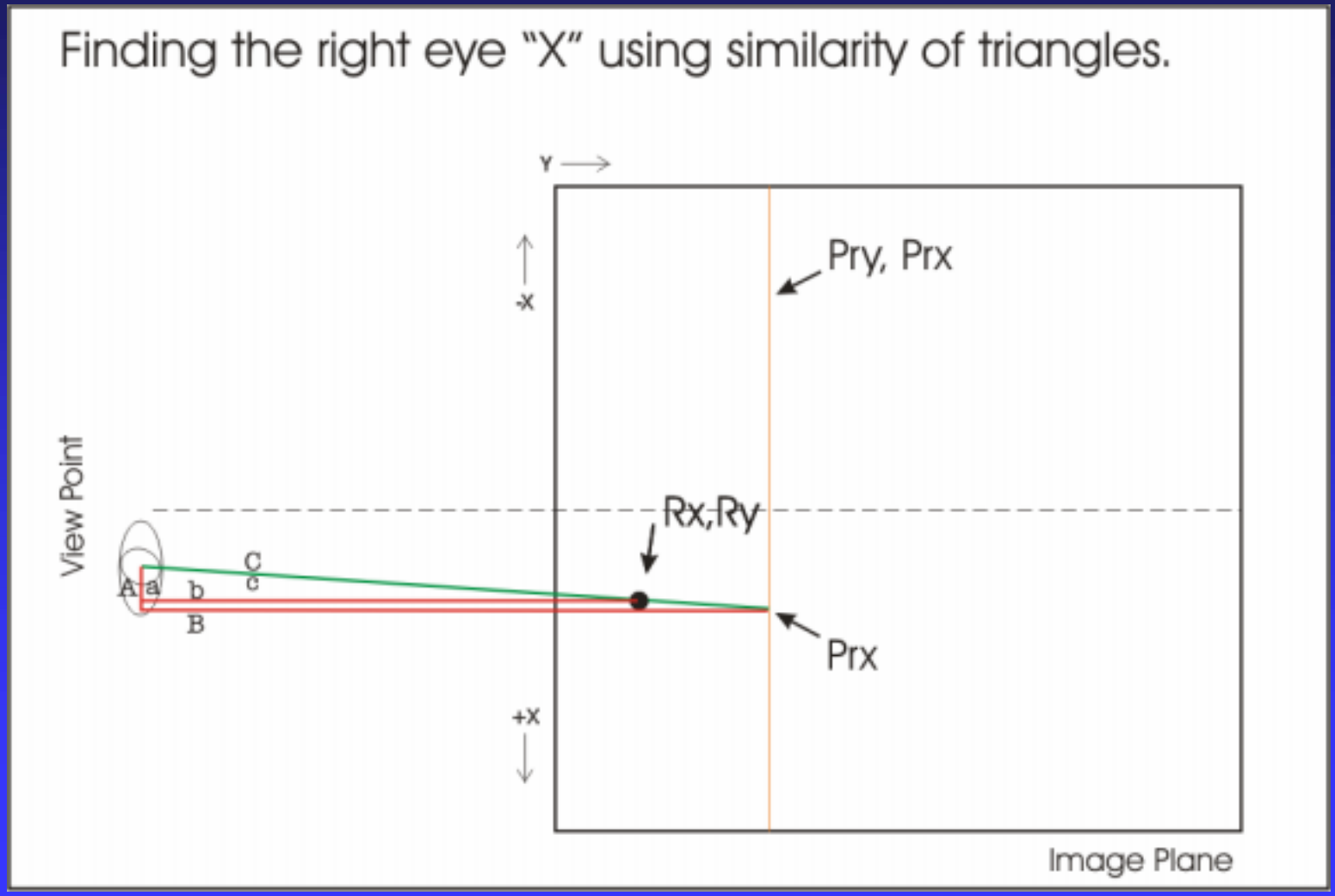
Lets Treat It As A 2D Problem



Left Eye “X”


Finding the left eye "X" using similarity of triangles.
Y
-X
Pry, Ply
View Point
C
c
A
a
b
B
Rx,Ry
Plx
+X
Image Plane

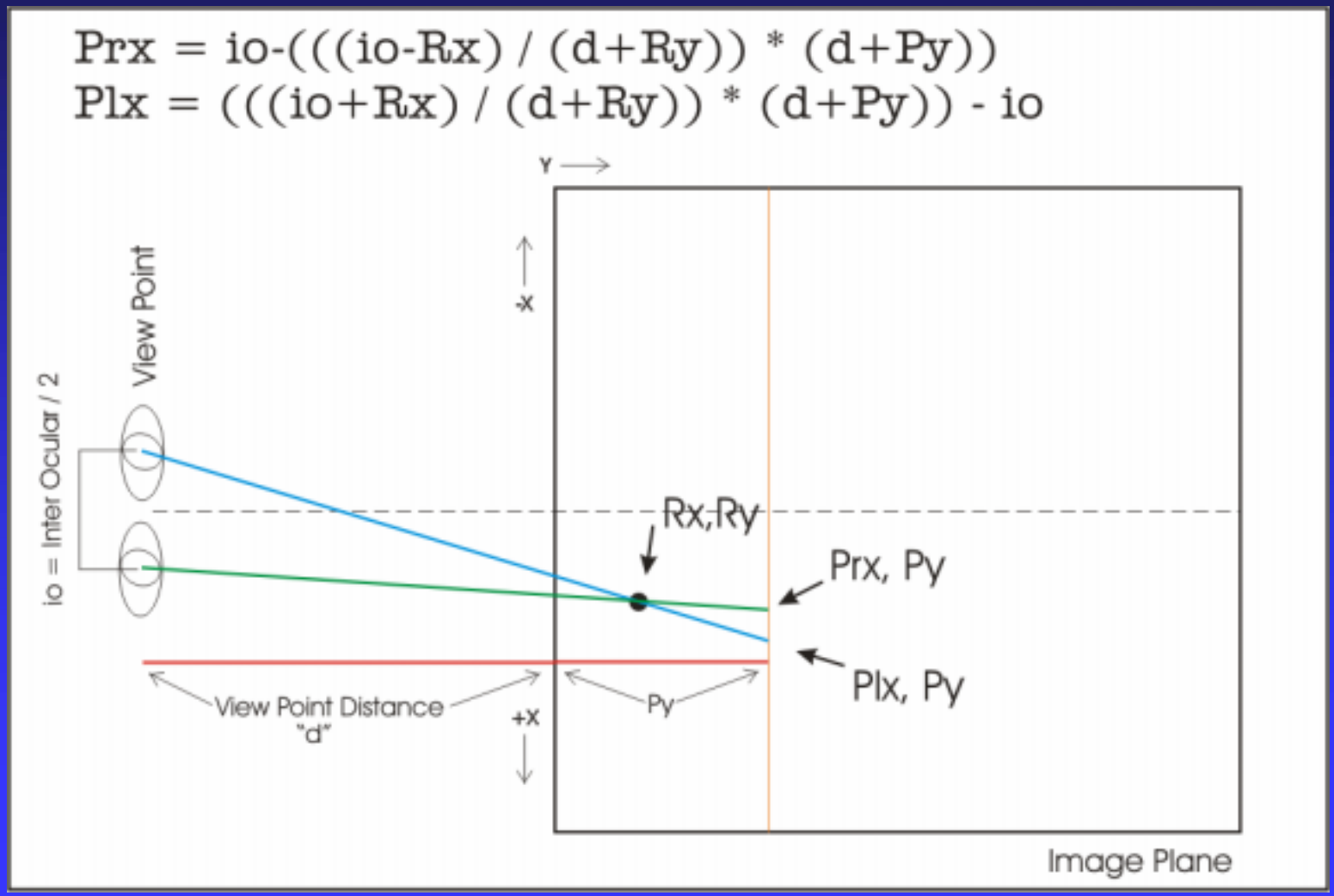
Right Eye “X”


Finding the right eye "X" using similarity of triangles.
Y
-X
+X
Pry, Prx
Rx,Ry
Prx
View Point
A
a
b
B
C
c
Image Plane

Formulas For “X”

$$Prx = io-(((io-Rx) / (d+Ry)) * (d+Py))$$

$$Plx = (((io+Rx) / (d+Ry)) * (d+Py)) - io$$



Creating CGI Phantograms

- These drawing formulas may be used in “3D” drawing programs to output Phantograms
- Implement them as “filters” to convert from drawing X,Y,Z coordinates to output files

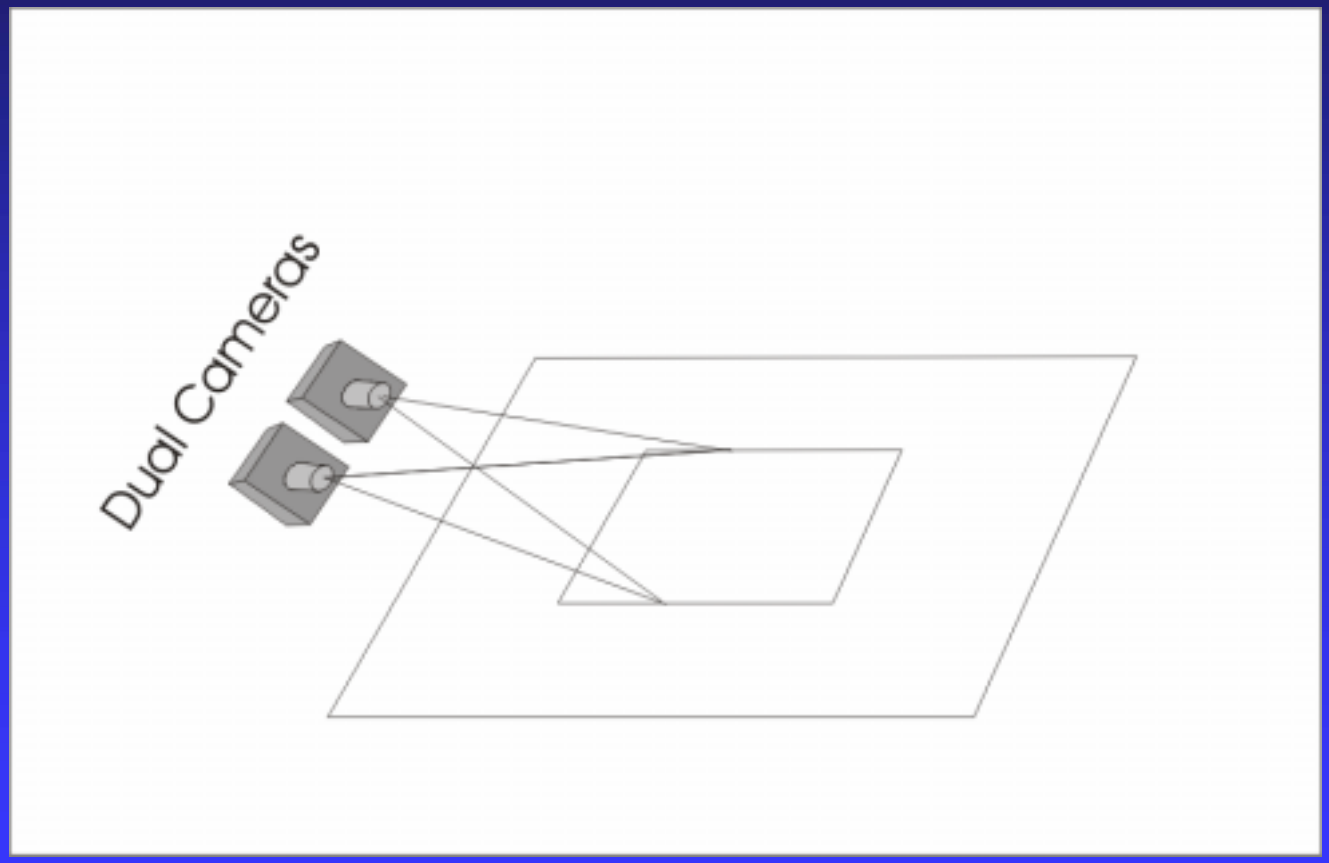
Photographic Phantograms

- Really quite simple
- Take two shots at an angle to the subject
- Process the photos to remove perspective and camera image plane distortions
- Map each image point to the viewing plane
- Combine the images in some convenient stereo format and Instant Phantogram!
- Of course there are a few details

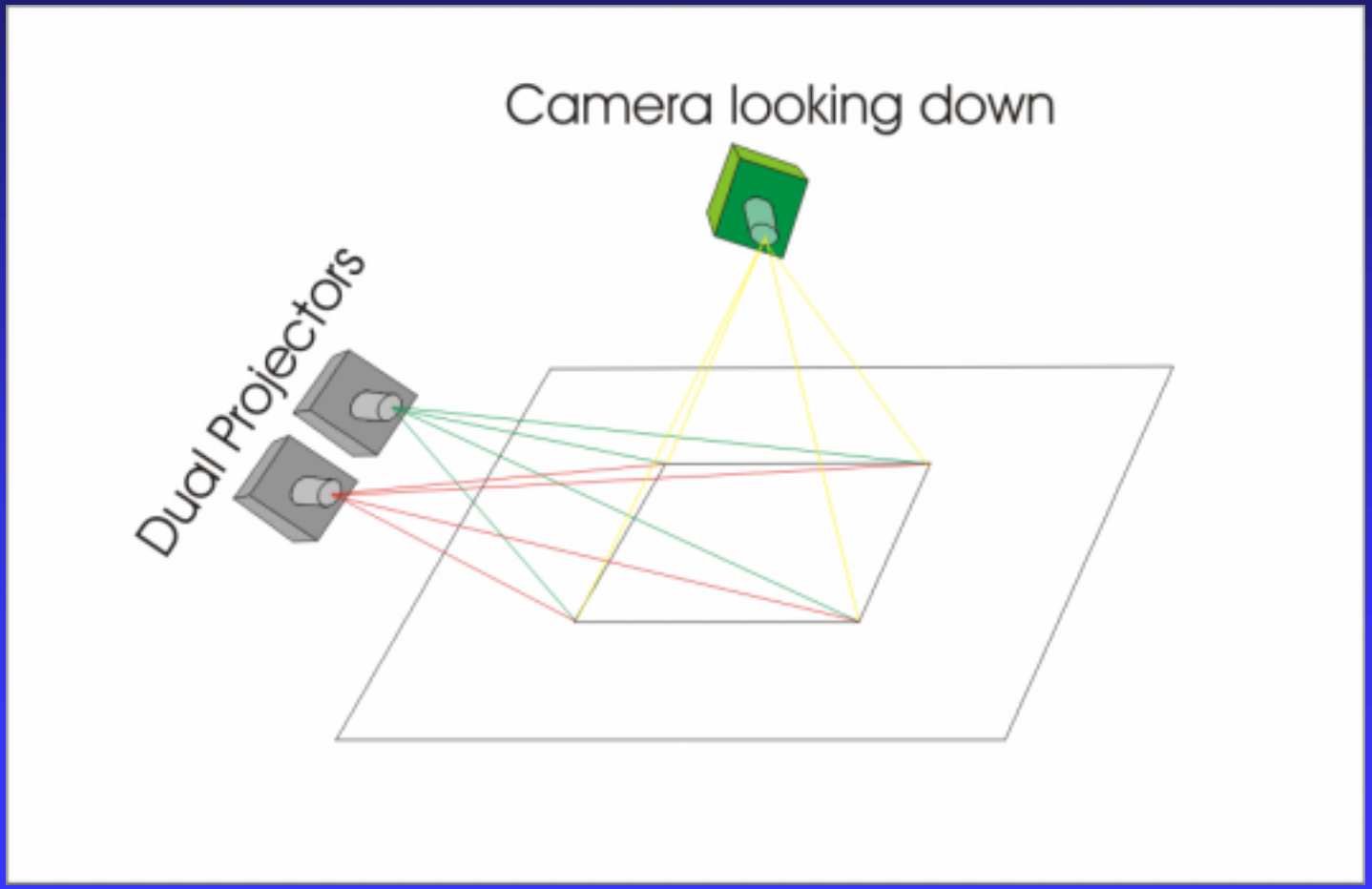
Making Them Yourself

- Many ways to do so
- “Dual Projector”, “Surface Mapping” and “Perspective transformation”

Dual Projector Method



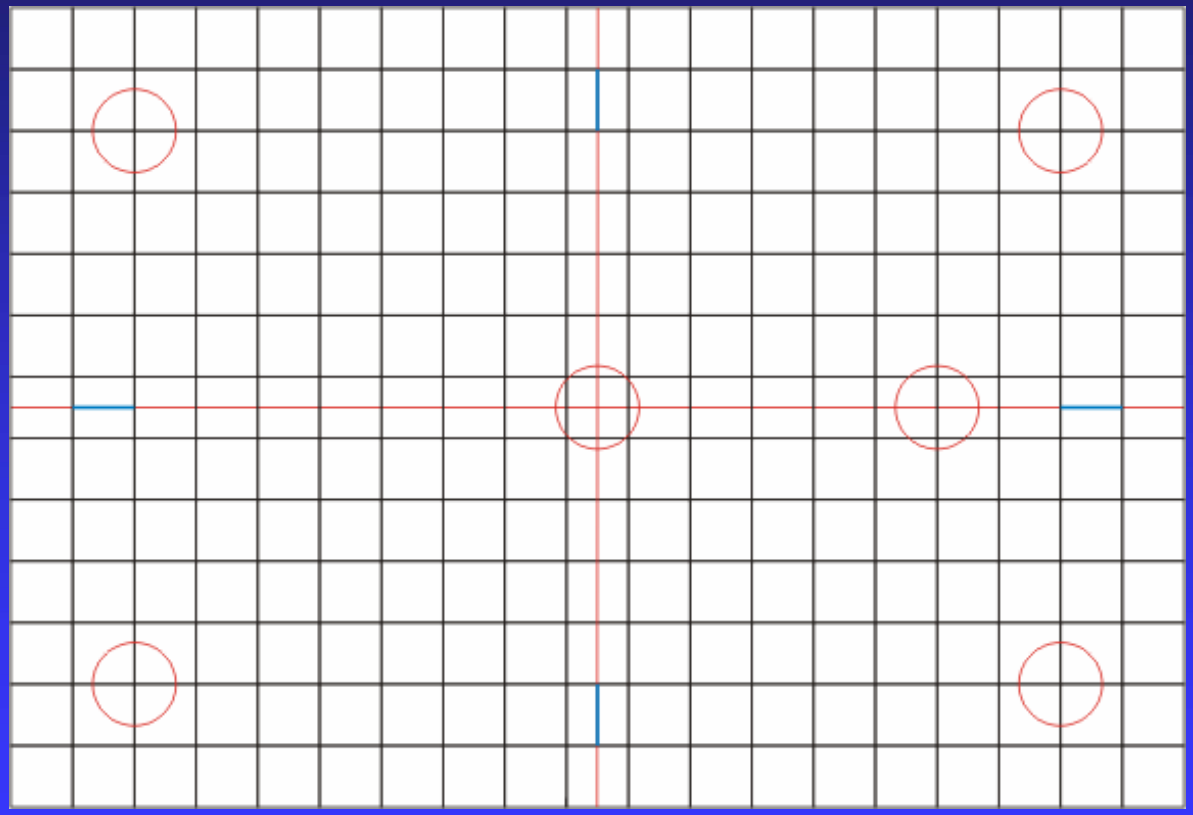
Dual Projector Method



Perspective Transformation

- This is one simple way using PhotoShop
- Digital camera on slide bar is easiest
- Fairly nasty math involved in understanding why it works
- Instead of calculations we will use an alignment grid / image target
- I actually use a projective transformation equation but Photoshop works well

Alignment Grid



Alignment Grid

- Use to align the camera with the object to be photographed
- Best for “table top” photography
- Make test shots of the grid to verify alignment
- Replicate this design

Image Target

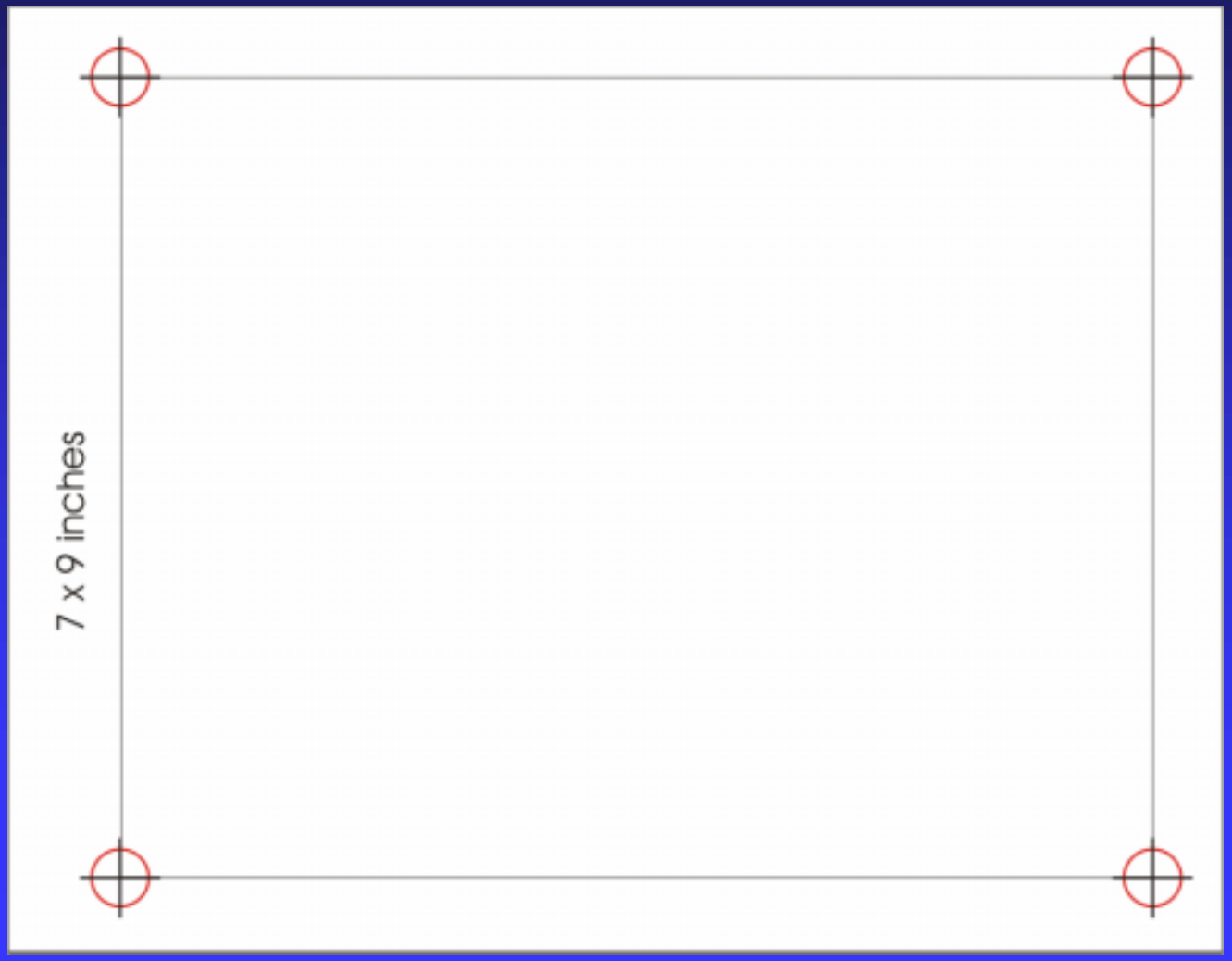


Image Target

- The image target and it’s design are the key to my method of making Phantograms
- This target design “calibrates” the space around the object to be photographed
- It allows using simple transforms to correct the camera image for perspective distortions

Image Target

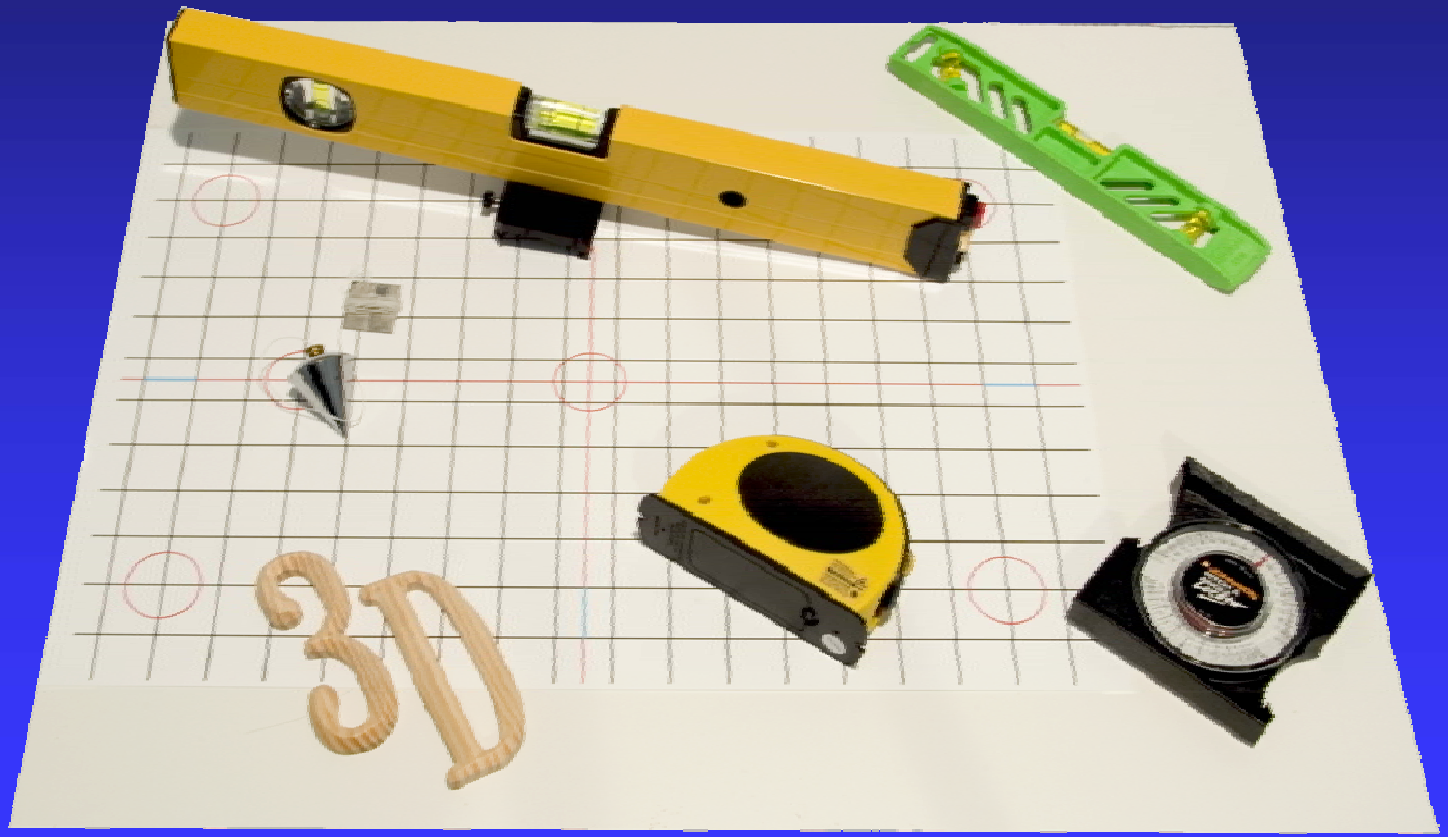
- Allows use of simple image processing algorithms to automate making Phantograms
- No “cut and try” procedures or “artists eye” needed
- Replicate the targets as I show them
- You may need to make one for each image

Basic Camera Setup

Camera Setup

- Camera should be at a 45 degree angle
- Camera in the exact middle of the setup grid
- Slide bar must be parallel to the grid
- Normal eye spacing for the left / right images
- Camera should point at the center of the object
- Alignment is critical

Alignment – Useful Tools

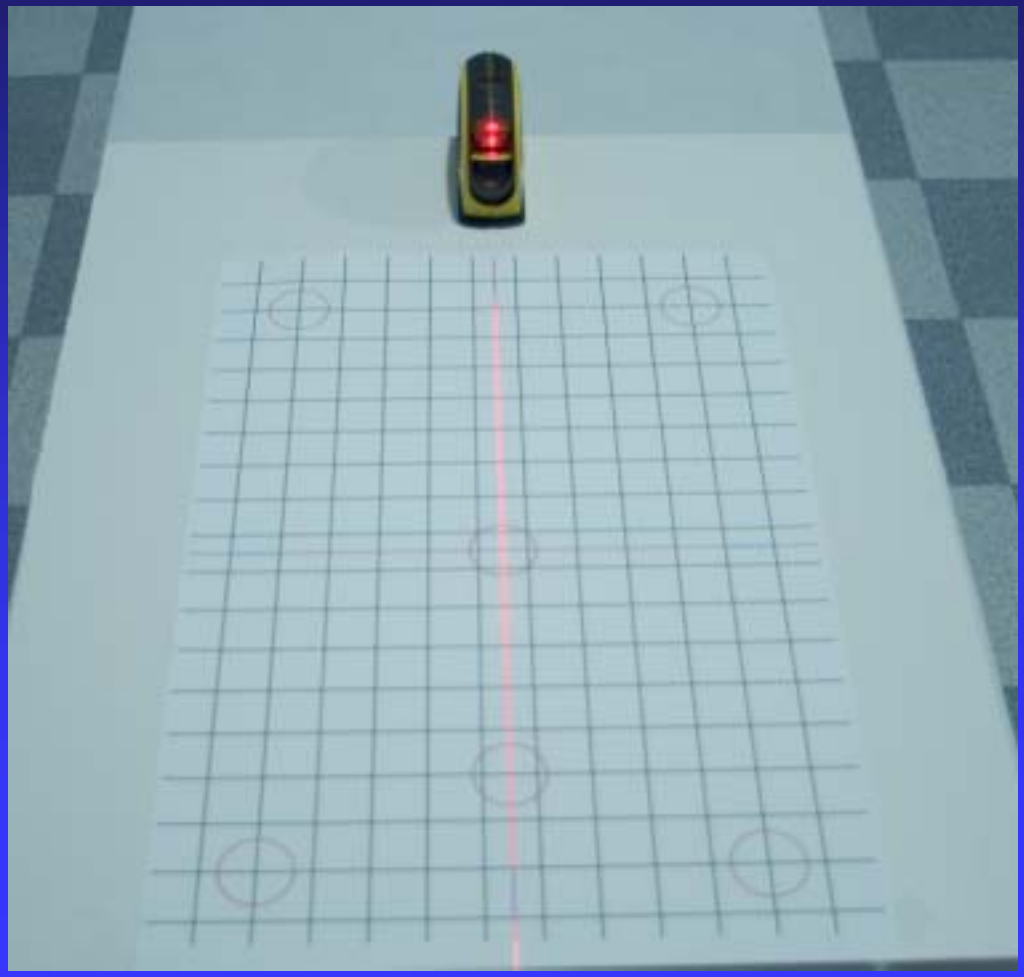


Level the Slide Bar

Set Slide Bar to 45° Angle

Center Camera on Grid and Locate Object

Setup Laser Pointer on Grid

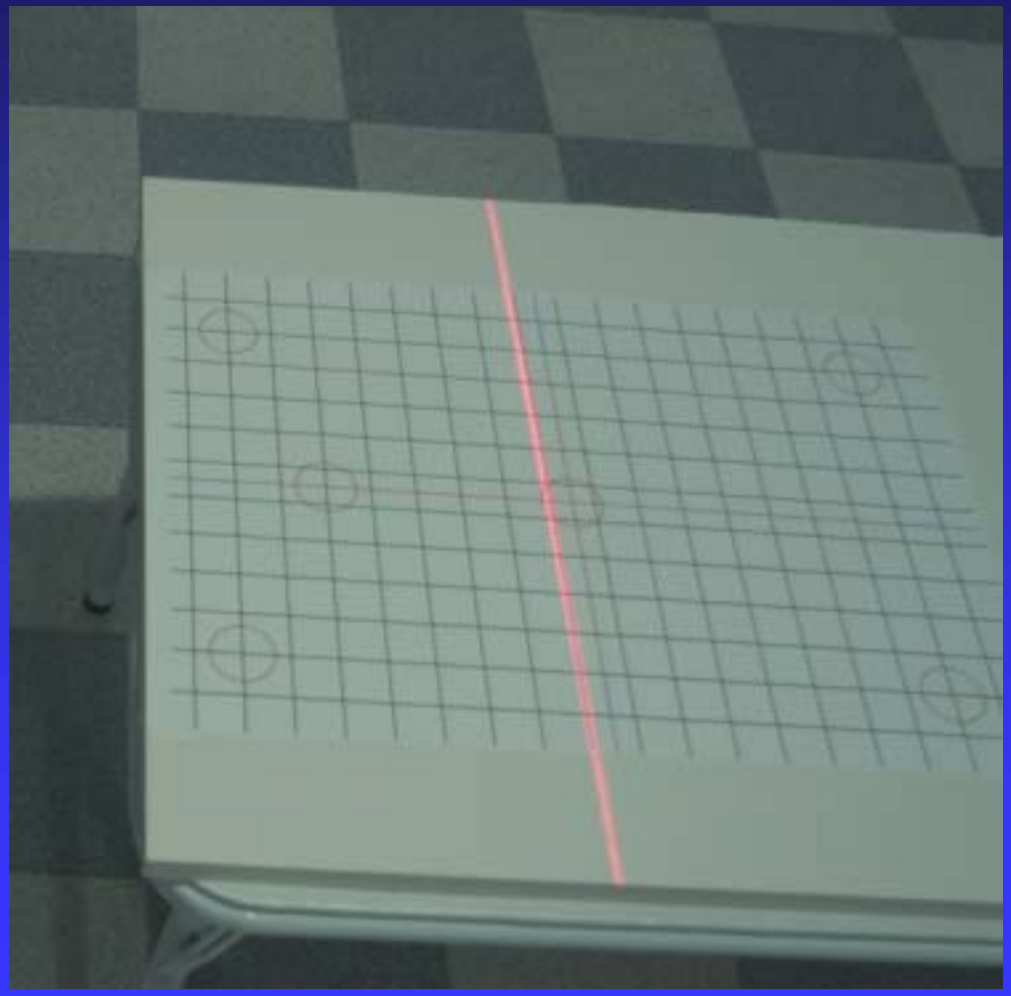


Hang Plumb Bob From Slide Bar Center Line

Use Laser Dot To Set Center

Mount Laser Level On Slide Bar

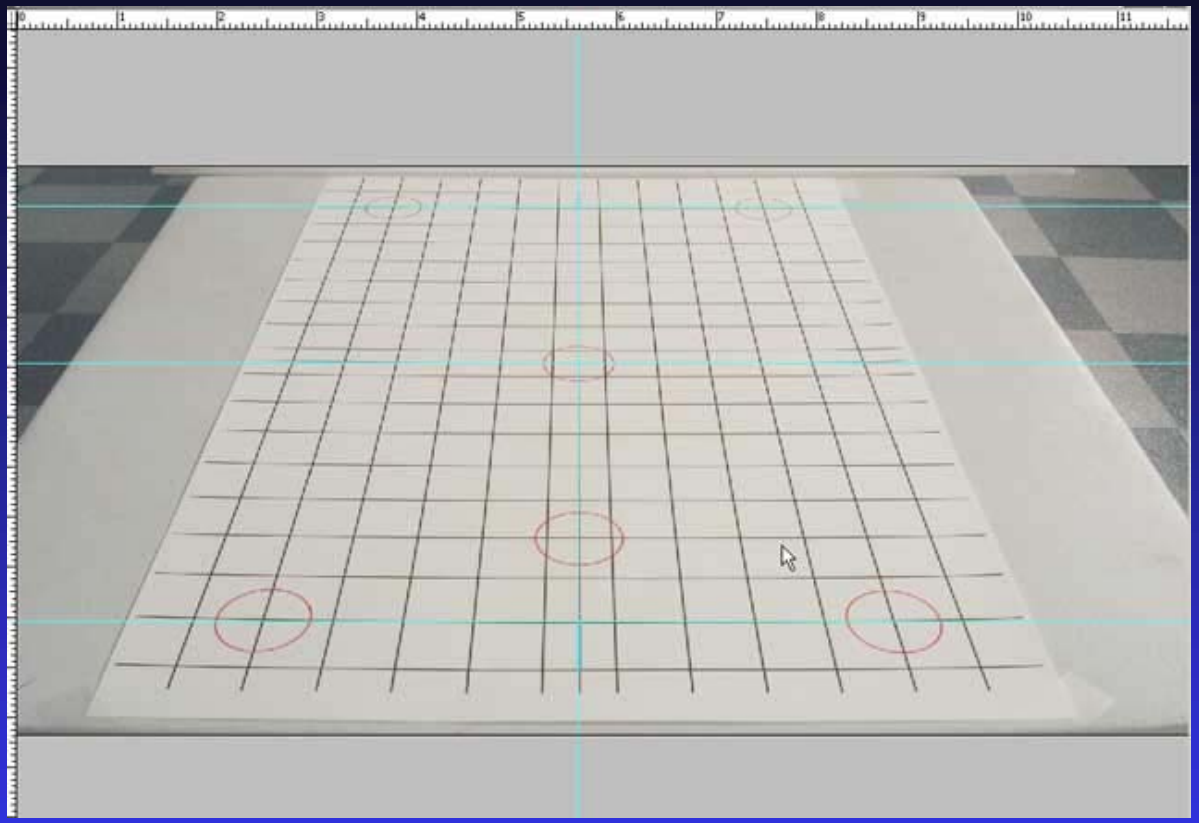
Use Grid To Check Alignment



Shoot Grid To Test Setup

Check Setup With Grid Shot

- Open in PhotoShop
- Pull “guide lines” from the top and line them up with the horizontal grid lines
- Pull one “guide line” form the side and line it up with the center vertical grid line
- Check alignment with “guide” lines



This shows the target grid with horizontal and vertical “guide” lines. The vertical guide line should line up with the center vertical line of the alignment grid. Horizontal guide lines should line up with any horizontal line.

Shoot Object

- Place object on target grid with camera pointing midway up object
- Make sure all four targets are visible and do not interfere with the object or it’s shadow
- Shift to left and shoot; shift to right and shoot using “eye” spacing

Procedure Using PhotoShop

- Open both images then make the backgrounds into layers
- Crop images to show just the “target” grid
- Perspective crop images to center of targets
- Size images to match original target grid
- Save as “right_rough” and “left_rough”

Open Both Images

- Use the “Layer ; New; Layer From Background” commands to create a layer
- Name it “left” or “right” as appropriate
- Save it for future use
- Now we will go through the procedure for processing one image of the pair you must do both left and right

Corp It To Just the Target Grid

This show a typical “left” image. The target is not centered in the image. Use the crop tool to cut out just the target.

Crop It To Just The Target Grid

The crop lines have been set just out side the targets.
The bottom targets set the horizontal space.

Image After First Crop

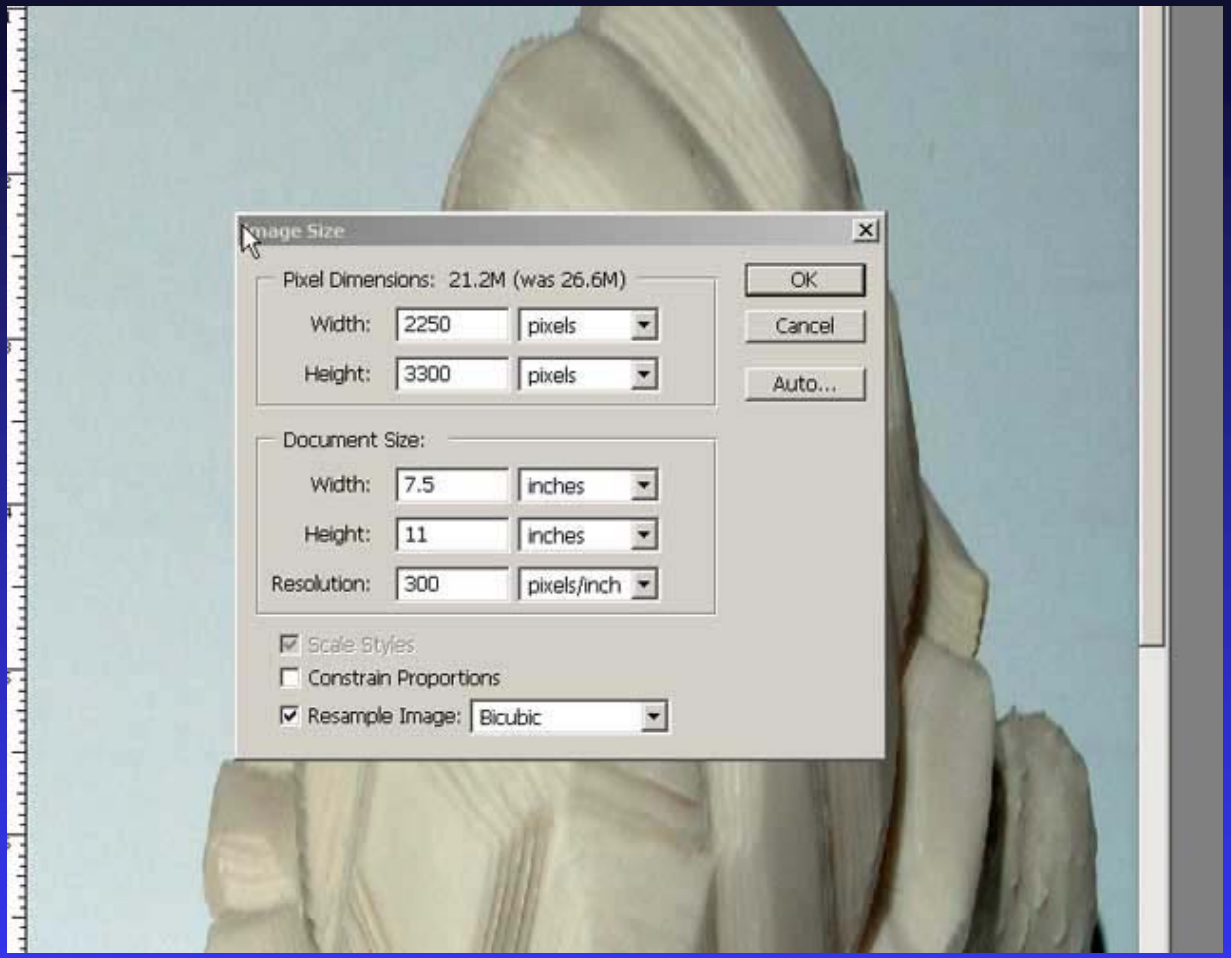
Perspective Crop Image

- Use the “crop” tool with the “Perspective” box checked to crop out just the target
- Drag each crop corner indicator to the center of a target
- Be as precise as possible!

Notice that the crop lines are right on the target grid lines. Be very precise and consistent!

Restore Image Size

- The image size may be distorted by the cropping operations
- Restore it to the target grid size using the “Image; Size” command
- Do not attempt to change the finished image size at this point
- Save it as “left_rough” or “right_rough”



Set the image size to the target grid size. You must not have “Constrain Proportions” checked.

This is the processed image showing part of the targets in each corner. These are used to set the “window”.

Finishing the Phantogram

- Normally the two files you just created are ready to process into an Anaglyph
- The semicircles left over from the targets define the stereo window
- Align the semicircles in both images for perfect “window” placement
- Never try to set the window using the images!
- Use any stereo image creation program or PhotoShop to complete the image

Finishing the Phantogram

- I recommend using either Pokescope Pro http://www.pokescope.com/ or StereoPhoto Maker http://stereo.jpn.org/eng/
- A procedure for doing this in PhotoShop is outlined in the next two slides

Set the “Window”

- Open “left_rough” and “right_rough” files
- Paste “left” into “right” as a layer
- Set opacity to 50-60%
- Set window using targets and crop to size
- Use “left” layer to create “Left” file
- Delete “left” layer and save “right_rough” as “Right” file

Now to make a simple anaglyph

- Open both files
- Select the “Red” channel from the left image
- Paste it into the “Red” channel of the right image
- Save anaglyph

Problems – “Fuzzy” Image

- Depth of field is very important
- Pixel smear due to too much manipulation
- Pixel loss due to too great a perspective / scale change
- Image enlarged too much

Problem – Distorted Image

- Leans back: inter ocular base too small
- Leans forward: inter ocular too large
- Too tall: “scale” too great
- Too short: “scale” too small
- “Squat” looking: “perspective” too large or small

Problem: Image Plane Wrong

- Tilted down or up: “perspective” correction is wrong
- Tilted to one side: “perspective” correction different in L/R images
- Tilted toward a corner: camera not parallel to image

Last Thoughts

- Always check your setup at the start of a shoot
- Remember it’s supposed to be fun!
- Information came from:

  Abram Klooswyk, Bruce Springsteen, Boris Starosta, Owen Western