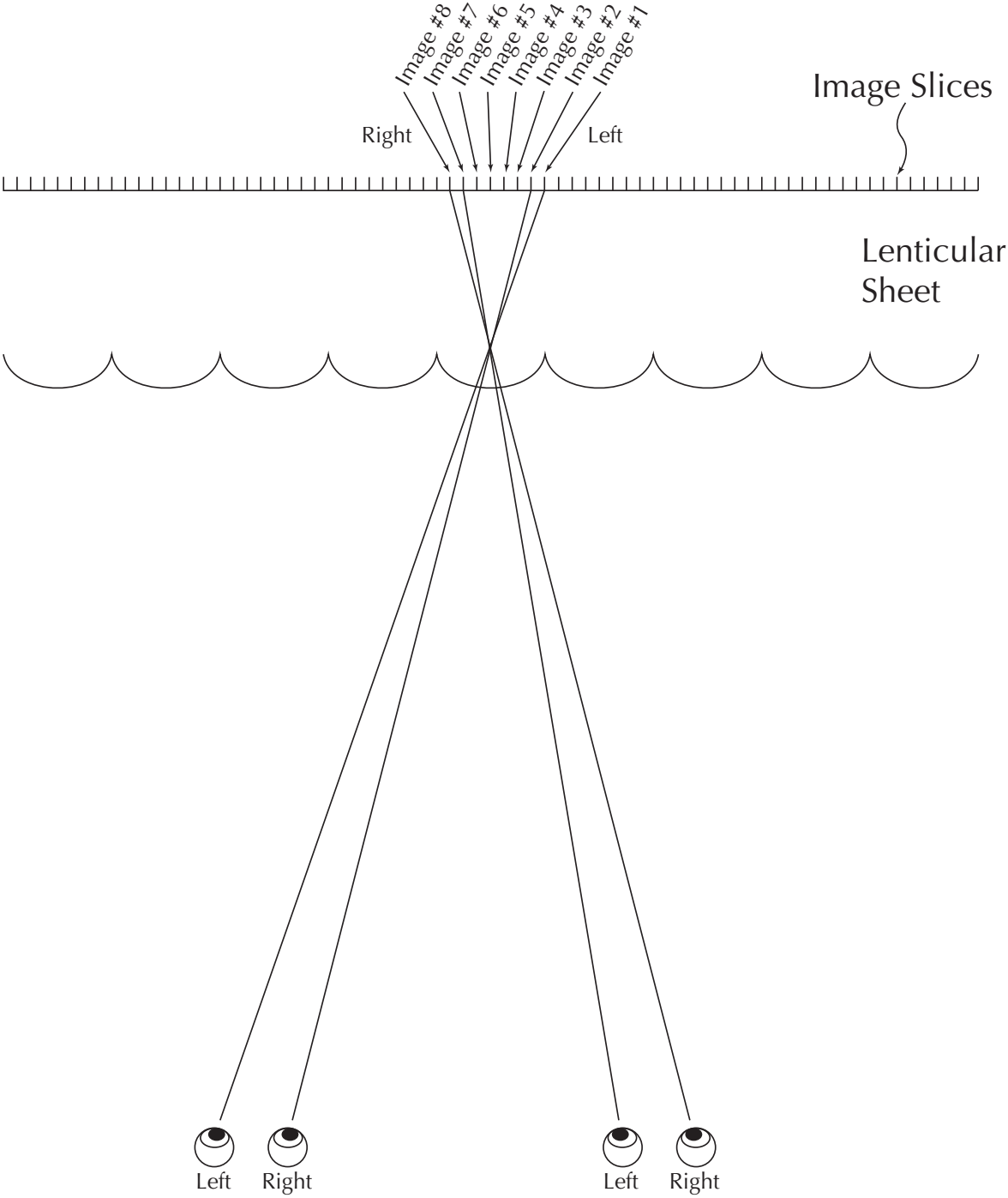# Lenticular Images using StereoPhoto Maker
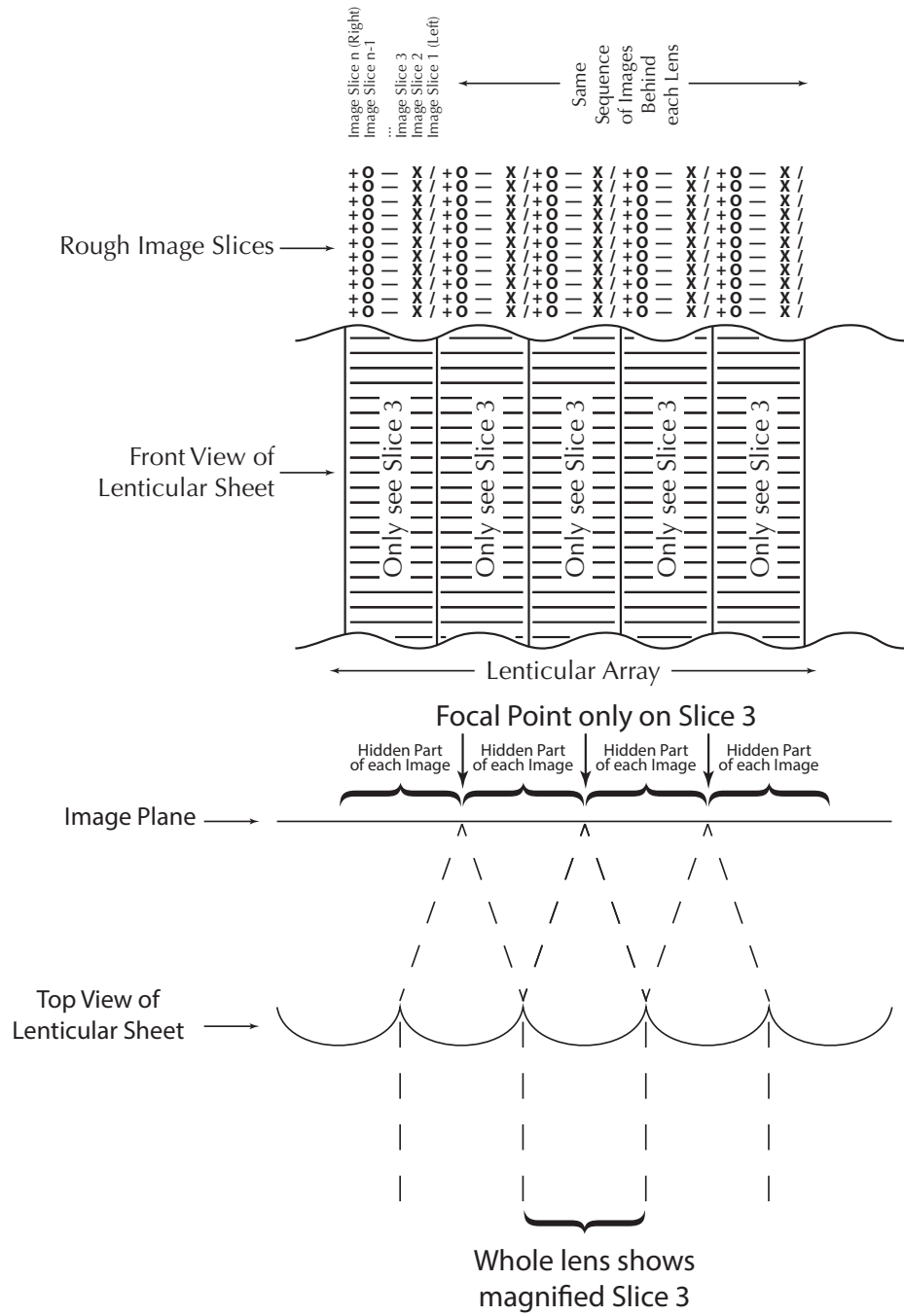
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and Herb Weiner herbw@wiskit.com

1) Discussion on how lenticular 3D works. See Figures 1 and 2.

2) Methods of taking lenticular images.

   a) Rig up many cameras on a bar to trigger by one shutter control.

   b) Use one camera on a slide bar at many positions.

3) Guidelines: three formulas for helping set up the multi image shoot.

   a) Number of Images Required = Printer Resolution (DPI) / Lenticular Lens Pitch (LPI). Note: Use the printer **hardware** resolution (or some fraction of it) in Dots per Inch or Pixels per Inch; **not** the halftone screen resolution. If the printer has different horizontal and vertical resolutions (the Epson Stylus Pro 9900 maximum resolution is 1440 x 2880) use the **smaller** value (or some fraction of it); e.g. 1440 or 720; **not** 2880.

   b) Distance = Scene Depth x 5. D = SD * 5.
Distance is the Distance from the Camera to the Set Point (see Step 9 on Page 4).
Scene Depth is the distance from the closest object in the scene to the furthest object in the scene (excluding any images at infinite distance).

   c) Camera shift = Distance (see formula b) / (8 X Number of images). Sh = D / 8 x N.
Camera Shift is the distance between consecutive shots. The Total Shift is Sh * (N - 1).

4) Other helpful suggestions

   a) Start on the LEFT moving to the RIGHT.

   b) Make sure nothing moves during all the images you take.

   c) Make sure the zoom, focus or other camera settings don't change with each exposure.

   d) Try not to tilt the camera left/right or up/down differently as you take each image.

   e) Compose the image using the zoom to cover more width (wider angle) than the image you want to end up with (because you will need to crop the images on Page 4).

   f) Pick the object in your image (the Set Point in Step 9 on Page 4) that you want to be at the lenticular sheet level and make sure that object is near the center most part of the images. This object should be about half way between the closest item and farthest back item. This part of the image will be at the lenticular level and it will be the best focused part of the lenticular image.

   g) Take a few more images than the number required (see formula 3a above), and use the best (equally spaced) images.

   For 600 DPI printers, and the 40 LPI lenticular sheet stock, you will need 15 images (600 / 40). For 720 DPI printers, and the 40 LPI lenticular sheet stock, you will need 18 images (720 / 40).

   h) Finer lenticular screens (higher numbers; e.g. 60) work best when viewed at closer distances; courser lenticular screens (lower numbers; e.g. 40) work best when viewed from further away.

   i) Save all your images in a new (easy to find) folder on your computer.

Figure 1: Viewing from two Different Positions

Image #8 Image #7 Image #6 Image #5 Image #4 Image #3 Image #2 Image #1

Right   Left

Image Slices

Lenticular
Sheet

Left   Right   Left   Right

Figure 2: Lenticular Lens Diagram

Image Slice n (Right)
Image Slice n-1
...
Image Slice 3
Image Slice 2
Image Slice 1 (Left)

Same Sequence of Images Behind each Lens

Rough Image Slices →

+O — X / +O — X / +O — X / +O — X / +O — X /
+O — X / +O — X / +O — X / +O — X / +O — X /
+O — X / +O — X / +O — X / +O — X / +O — X /
+O — X / +O — X / +O — X / +O — X / +O — X /
+O — X / +O — X / +O — X / +O — X / +O — X /
+O — X / +O — X / +O — X / +O — X / +O — X /
+O — X / +O — X / +O — X / +O — X / +O — X /
+O — X / +O — X / +O — X / +O — X / +O — X /

Front View of Lenticular Sheet →

Only see Slice 3   Only see Slice 3   Only see Slice 3   Only see Slice 3   Only see Slice 3

← Lenticular Array →

Focal Point only on Slice 3

Hidden Part of each Image   Hidden Part of each Image   Hidden Part of each Image   Hidden Part of each Image

Image Plane →

Top View of Lenticular Sheet →

Whole lens shows magnified Slice 3

3

Using StereoPhoto Maker to Process images

1)   Start StereoPhoto Maker and select: *File > Multiple Images > X-Y adjustment and cropping*.

2)   Find and open your new image files. Set "Output File Type" to your preference (I use JPG, but TIFF would be less lossy). Make sure the "Output Folder" is where you want to store the processed images. If you want your results in the same folder, enter a unique prefix name in "file Prefix" (otherwise SPM will overwrite your original images).

3)   Select the images you want to look at and click on "Adjust Selected Files" or click on "Adjust All Files".

4)   Click on "Test" and SPM will display all the images sequentially (this may take a while as SPM's progress is slow and is shown at the top left of window).

5)   If your images tilt or bounce up and down too much as they are presented, you need to let SPM align your images. Cancel out of "test" and exit "X-Y adjustment and cropping".

6)   Select *File > Multiple Images > Auto rotation adjustment (one by one)*.

7)   Before you start, make sure you choose a different "Output Folder" or change the "File Prefix" so you don't over write the original images. Select the images you want to use and click on the appropriate "Adjust Files" button. This can take several minutes if there are many large images.

8)   With the new images repeat steps 3 and 4 and the images will be improved.

9)   Now click "Set Point" and set the cross hairs on a sharp point in the image that you want to be in the level of the lenticular sheet of your picture (half way between the back most part and the fore most part of the image. Set this same point on each of the images.

10) Click on "Mask" and SPM will show the part of this image that is common to all the images.

11) Click on "Crop" and select the part of the image that you want.

12) You can click on "Test" to see what the results of your efforts are.

13) Click on "OK" and SPM will crop all the images to the common point you selected and save them where you said with the new prefix you input. Otherwise it will overwrite the original images.

14) With the new aligned and cropped images repeat steps 3 through 4 and the images should move smoothly from left view to right view. These new images will be what you will want to process to make the lenticular image for printing.

Using StereoPhoto Maker to Slice up and Save or Print your images

1) In StereoPhoto Maker, *Create Lenticular Image*:

   a. For versions 5.24 or older, select *File > Multiple Images > Create Lenticular Image...*

   b. For versions 5.30e or newer, select *Edit > Create Lenticular Image...*

   Find your folder with your image files and select the finished images you want to use for the lenticular.

2) Set the box "Lenticular Lens Pitch" to 40 (or the pitch of the lenticular sheet you have)

3) Set the box "Printer Resolution" to 720 (or whatever your printer resolution is). If your printer is capable of multiple resolutions (e.g. 720 or 1440), select the resolution suitable for the number of images you have and the Lenticular Lens Pitch you are using (see formula 3a on page 1). (See 9 and 10 below on Printer Resolution.)

4) Set the box "Print width" to the size of your final print. (I would recommend using the actual width of the lenticular sheet you want to use.)

5) Make sure "Image Direction (from left to right)" is checked

6) Select your images and click on "Create with Selected Files". Wait a while and POP! You have the image file to be printed.

7) Select *File > Save Image* and (if you are saving in JPG format) set the "image quality" to 99. Locate your folder and save this file with a new name.

8) To print this sliced up image, select *File > Print Setup* From the main StereoPhoto Maker window.

9) Click on the "Printer" button in the lower right of the window to set up your printer.

10) Select your printer properties. Set to "Best Photo Quality" and "Best Photo Paper". These names may be different with your paper and on your printer. Get back to the StereoPhoto Maker "Print" window.

11) Note that StereoPhoto Maker now shows the printer resolution that your printer is using in the upper right side of the window. **This number (detected by StereoPhoto Maker) should be used in all previous steps requiring printer resolution!**

12) Make sure the box "Print dot by dot" is selected. The image should show up in the window the size and position it will be printed. Move the image to the top and in the middle of the print page. There should be a small margin on both sides of the image.

13) Load the good photo paper, make sure "text enable printer" is <u>not</u> checked and print your image.

   -- for this class, I have provided a printed 3D image with a pitch test pattern printed on the lower half of the paper. Looking with one eye directly over the test pattern you can use this test pattern with the instructions on the following page to adjust the position of the lenticular sheet and see how it interacts with the printed image. When adjusted correctly, the black image of the test pattern should be in the center of the lenticular sheet and cover most of the width of the sheet. To generate a custom print test pattern, see page 7 of this handout. –

Mounting your printed image to the lenticular sheet

1) After you image dries so you can touch it without smearing it (sometimes it takes several minutes), lay the print flat on the table

2) Your lenticular sheet should just cover the printed image with about ¼" free on each side. Place the lenticular sheet over the image.

3) Holding the image down with your finger tips on the edges of the paper, adjust the position of the lenticular sheet (rotating and moving L/R) relative to the image so that the image appears in 3D when viewed straight on. This is how the 3D image should look.

4) If you don't have adhesive on the back of your lenticular sheets, then tape the photo to the sheet and you're done.

5) To mount a lenticular sheet to your image if the sheet has adhesive on the back, fold back about 1" of the backing on the top of the sheet. Now add small pieces of tape to the folded back part of the backing so you can get hold of the backing to proceed.

6) Being really careful not to let the uncovered adhesive area touch the image, place the lenticular sheet over the image and repeat steps 1-3 above to align the sheet. The folded backing should keep the adhesive from touching the image. When you have the lenticular sheet adjusted just right, holding the sheet steady, press down on the top to attach the lenticular sheet to the image.

7) With the top attached, pull the backing down about 1" with the attached tapes ends and press the sheet down to the image trying to prevent any air bubbles from forming.

8) Repeat step 7 until you have the whole image attached to the lenticular sheet. If there are places on the image that aren't quite attached, turn over the 3D image and using an object like a hand applicator squeegee or the back of a comb to work out all the areas where the image is not yet stuck to the lenticular sheet. If there are large air bubbles, you'll have to puncture the paper with a pin or sharp pointed knife and work out that bubble. When done, cut away the edge of the paper with scissors or a #2 X-ACTO Knife on a cutting mat.

9) If you have access to a cold laminator, then use that instead of steps 7) and 8) above. Refer to this video: https://www.youtube.com/watch?v=PPwBuOVze-E&feature=emb_logo
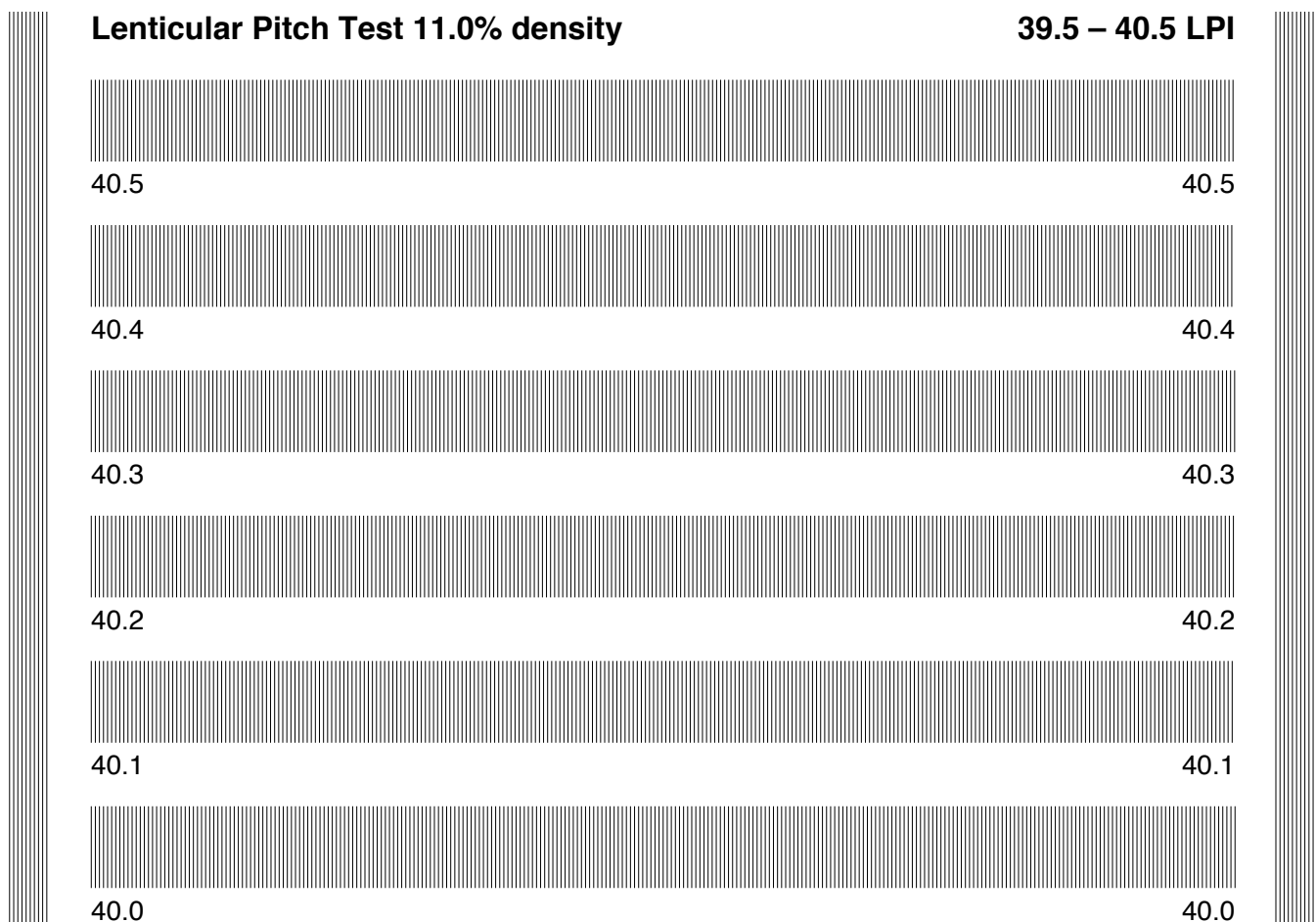
Advanced Notes on Lenticular Printing

1) Lenticular sheets and printers are sometimes not exactly equal to each other in pitch. SPM will only do whole numbers of line pitch – it will truncate a decimal fraction to a whole number to do its processing. Using SPM, if I put in "60.15" it truncates the decimal and does 60Lpi. VueThru's SuperFlip software (http://www.vuethru.com/filedownload.html) will do fractional values of LPI (it works with a number like 60.18).

A few printers and lenticular sheets don't exactly match the specified 40 LPI or 60 LPI but for smaller images this isn't a problem as the 3D will still work. For larger 3D images another method like Photoshop or SuperFlip can be used to make small adjustments to the pitch of the printed image to match any lenticular sheet.

http://www.3dpdx.org/lentpitch.cgi?minimum=39.5&maximum=40.5&density=11

(The following figure shows only the top half of the PDF generated by the above.)

Lenticular Pitch Test 11.0% density   39.5 – 40.5 LPI

40.5   40.5

40.4   40.4

40.3   40.3

40.2   40.2

40.1   40.1

40.0   40.0

2) SPM seems to only print "point for point". When you use a 720dpi printer and set SPM to 60LPI everything is just fine – you get exactly 12 images (points) for each lens. See note above about decimal values with SPM. I always use SPM at exactly 60.00LPI for a 720dpi printer and then use Photoshop to change the LPI by printing the picture just a tad larger or smaller as needed for my particular lenticular sheet. Photoshop will blend the adjacent pixels at the edges of each image strip of the lenticular images and it doesn't show like SPM.

3) Lenticular images should be printed with the viewing distance in mind. A small image may be viewed at 10″ to 18″. A larger image may be viewed at 30″ to 40″. The angle that one's eyes see through the lenticular lenses is different at 10″ and at 40″. When you adjust the print LPI of your image for 3D affect over the whole image, make sure you test it at the distance you expect to be viewing it. Use only 1 eye to pick the proper alignment, because if you use both eyes, one eye sees one stripe and the other eye may see a different stripe 4 or 5 stripes away.

4) Some lenticular software automatically puts alignment strips on the top and sides of an image. (several black and white lines at the lenticular pitch) These are very useful when aligning the image to the lenticular sheet. If you don't have such software, you can do the same thing by making the 4 middle images of your set of 12 images have a small black border and the rest of the images have the same size white border. When it is printed you will have the alignment strips all around your image.

5) The free program "SuperFlip" will only do up to 60Lpi. SPM will try to slice up an image at 75Lpi but it doesn't really work at 75Lpi. As stated above, I only use SPM at 60 Lpi and use Photoshop to re-adjust the final printed (Photoshop printed) image to get the lenticular pitch that will fit the sheets I have. It takes a few tries. If I use the SPM with the settings listed below and then print with SPM with a printer at 720ppi, I can fool the system and get a test pitch that spreads around 60Lpi with 60Lpi in the middle.

http://www.3dpdx.org/LenticularCalculator.xls

Using the above Lenticular Calculator spreadsheet, if you set the printer dpi in StereoPhoto Maker and then print at 720dpi this fools StereoPhoto Maker and gives you the actual LPI shown in the spreadsheet.

Lenticular Calculator, Copyright © 2019 Herb Weiner <herbw@wiskit.com>

Instructions: Enter the desired values in B5 and B6. The values in the remaining cells are calculated.

| Actual Printer Resolution (DPI) | 720 |
| Actual Lens Pitch (LPI) | 60 |

| DPI Specified in SPM	Actual LPI Printed
732	59.02
731	59.10
730	59.18
729	59.26
728	59.34
727	59.42
726	59.50
725	59.59
724	59.67
723	59.75
722	59.83
721	59.92
720	60.00
719	60.08
718	60.17
717	60.25
716	60.34
715	60.42
714	60.50
713	60.59
712	60.67
711	60.76
710	60.85
709	60.93
708	61.02

6) As I mentioned, neither of the free slicing programs will work at 75 LPI. What I did to get a prepared image at 75 LPI was to process the image set at 60.00 LPI in SPM and save it at a width of 8.75". I saved it from SPM at 60 LPI and 8.75" wide. I then used Photoshop and reduced the overall size from 8.75" down to 7.00" and Photoshop did a great job in making the 60 LPI slices actually be 75 LPI. It's only simple math 8.75/7.00 = 75/60. If you want other values because your printer is not 720 PPI then you can use a different ratio.

7) Of the 2 programs listed, only SPM has a good auto alignment feature. If you use either SuperFlip or SPM to slice up your images, I would use SPM "Auto Rotation and Adjustment" and SPM "X/Y adjustment and Cropping" feature before trying to slice up and print your images. SuperFlip will also print a series of test patterns to check out your particular lenticular sheets. SuperFlip for some reason does not save in .JPG format.

8) There is another software called "3D-Easy" that costs about $50 that it will allow you to manually do the alignment and cropping. I think "3D-Easy" also does 75Lpi. 3D-Easy will put alignment patterns on all sides of your sliced up image and it can print a series of Lpi test patterns to test your particular lenticular sheets.

9) StereoPhoto Maker will only save lenticular images for printers that are actually installed on your system. (Actually, what is required is the print driver, not the physical printer.) If you need to save a lenticular image to be printed on a printer with different properties (e.g. a different resolution or larger size), you can install a virtual printer such as Universal Document Converter. For more information, refer to the next section.

10) For best results, you should print with interlaced lines vertical (perpendicular to the printer head direction) because most printers have higher precision printing in this direction. When printers have different horizontal and vertical resolutions, the higher resolution is usually the printer head direction and the lower resolution is usually the paper feed direction.

Using a Virtual Printer

If you need to save a lenticular image to be printed on a printer with different properties (e.g. a different resolution or larger size), you can install a virtual printer such as Universal Document Converter. Note that the demo (free) version allows you to specify any printer resolution (e.g. 1200 DPI) and size (e.g. 11 x 17) and save a lenticular image suitable for that printer.

1)   Download and install Universal Document Converter (https://www.print-driver.com).

2)   When you have your images loaded in StereoPhoto Maker, select: *File > Print Setup*.

3)   Click the Printer… button.

4)   From the Name dropdown menu, select *Universal Document Converter*, and click Properties. You should then see the Universal Document Converter Preferences window.
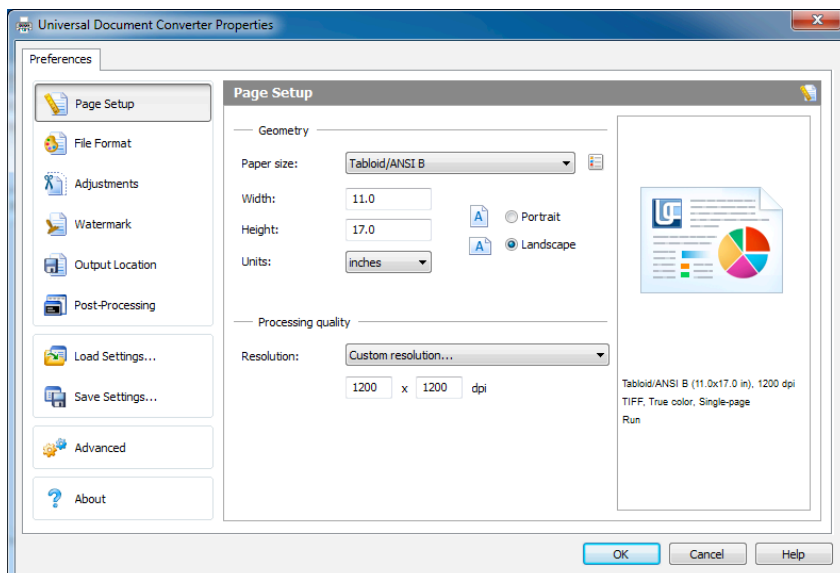
5)   Choose your desired paper size from the Paper size dropdown menu, or choose Custom Size… and enter the desired Width and Height. Choose Portrait or Landscape orientation.

6)   From the Resolution dropdown menu, choose Custom resolution… and enter the desired resolution in both boxes; e.g. 1200 x 1200 dpi.

7)   Click OK in the Universal Document Converter Properties window, then click OK in the small StereoPhoto Maker Print Setup window.

8)   Verify that the correct Printer Resolution and Page Size is displayed in the top right corner of the large StereoPhoto Maker Print Setup window.

9)   Ensure that the Print dot by dot checkbox is checked, then click OK.

10)   In StereoPhoto Maker, select: *File > Save Image…*

11)   For best print quality, save your image using a non-lossy file format, such as TIFF. Most service bureaus can print TIFF images.

Links / Resources / Suppliers

Lenticular Lenses

Approximate prices are: 8″ X 10″ with adhesive ~$3.50 each, in quantities of 25 sheets. 11″ X 14″ with adhesive ~$6.10 each, in quantities of 25 sheets. 16″ X 20″ with adhesive (if you have that big of a printer) ~$12.00 each, in quantities of 10.

- Be sure to purchase 3D (**not** Flip) lenses.
- Be sure to purchase the correct orientation (landscape or portrait) for your lenticular prints.
- You will probably want 40 or 60 LPI. (15 or 20 LPI lenses are intended for larger prints viewed at greater distances.)

Recommended suppliers are:

- https://store.vuethru.com/3d-lenticular-lens-blanks-c3.aspx
- http://www.microlens.com/pdfs/spec_sheet_ls-0602-03.pdf (you will need to phone them for a price list, since they do not post this online.)

Tools

- Cold Laminator: https://www.amazon.com/gp/product/B01N7AQKVY
- Lenticular Lens Cutting Knife: https://www.amazon.com/gp/product/B000C027ZE
- Hand Applicator Squeegee: https://www.amazon.com/gp/product/B01D223UWW
- #2 X-ACTO Knife: https://www.amazon.com/X-ACTO-2-Knife-Safety-Cap/dp/B000V1QV7O
- Self-healing cutting mat: https://www.amazon.com/Dahle-Vantage-Self-Healing-Cutting-Cropping/dp/B0027ROZ9G

Software

- StereoPhoto Maker: http://stereo.jpn.org/eng/stphmkr (freeware).
- SuperFlip: www.vuethru.com/filedownload.html (freeware).
- 3D-Easy: http://www.3d-easy.de (apparently no longer available).
- Lenticular Calculator (Excel Spreadsheet): http://www.3dpdx.org/LenticularCalculator.xls.
- Virtual Printer: Universal Document Converter (https://www.print-driver.com).

Instructional Materials / Videos / Reference

VueThru.com sells a lot of lenticular supplies and has several good videos that you can watch to get their suggested process to make lenticular images (http://www.vuethru.com/videos.html). They show Flip images but 3D images use same lenticular sheets with Vertical lenses.

Printing

If you are using a service bureau, find one (e.g. Pro Photo Supply, 1112 NW 19th Avenue, Portland, Oregon 97209, (503) 517-3639, https://prophotosupply.com) with a professional quality photo printer (e.g. Epson Stylus Pro 9900, with 1440 DPI resolution, for prints up to 44 inches wide). Be sure to save your lenticular images at a resolution supported by the printer, as described on page 5. Make sure the service bureau does **not** change the scale of your print. Print them at 100% and on good quality paper.

http://www.3dpdx.org/LenticularImagesUsingSPM.pdf
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