AUTO-STEREOGRAM INTRODUCTION

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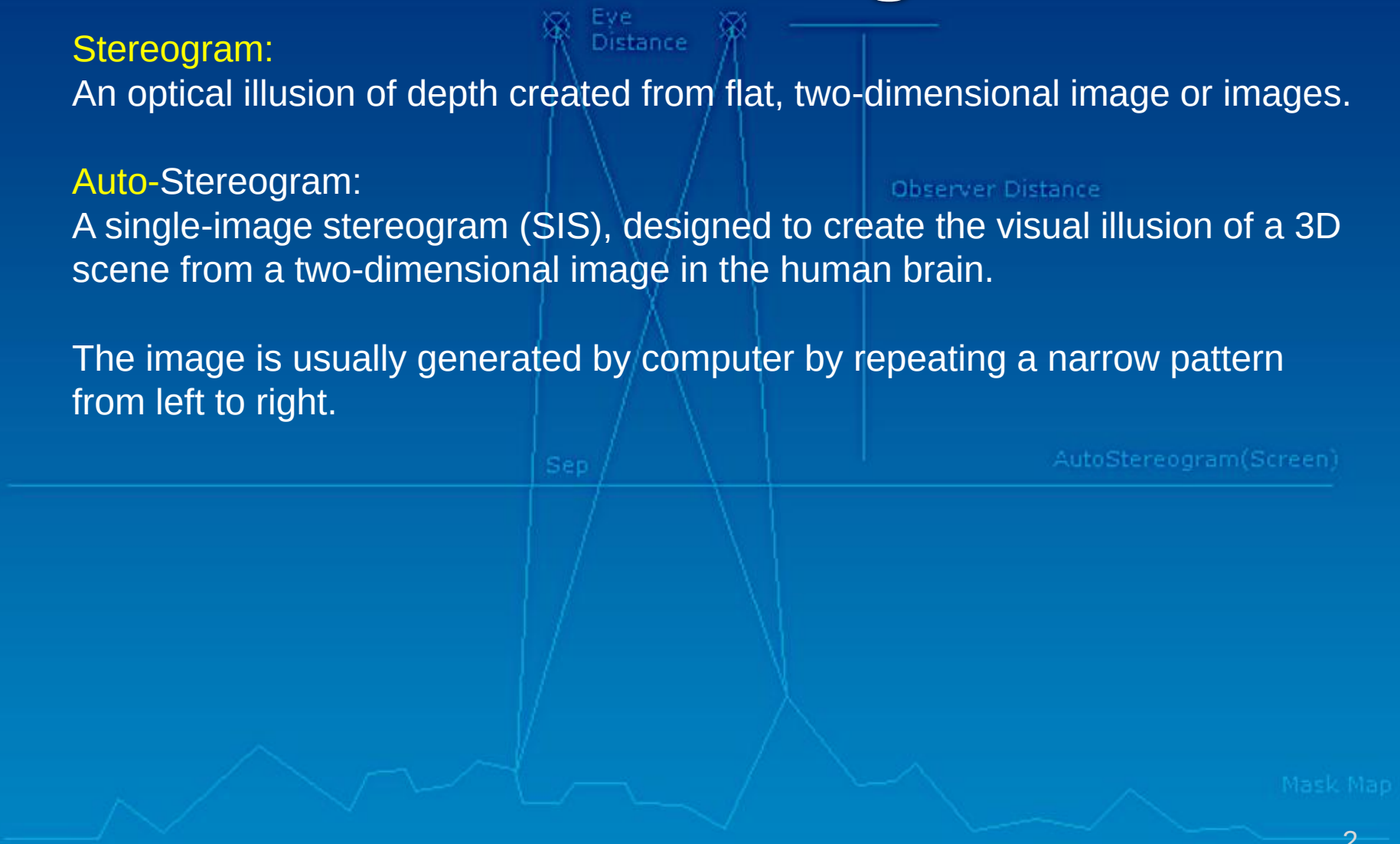
What is Auto-Stereogram?

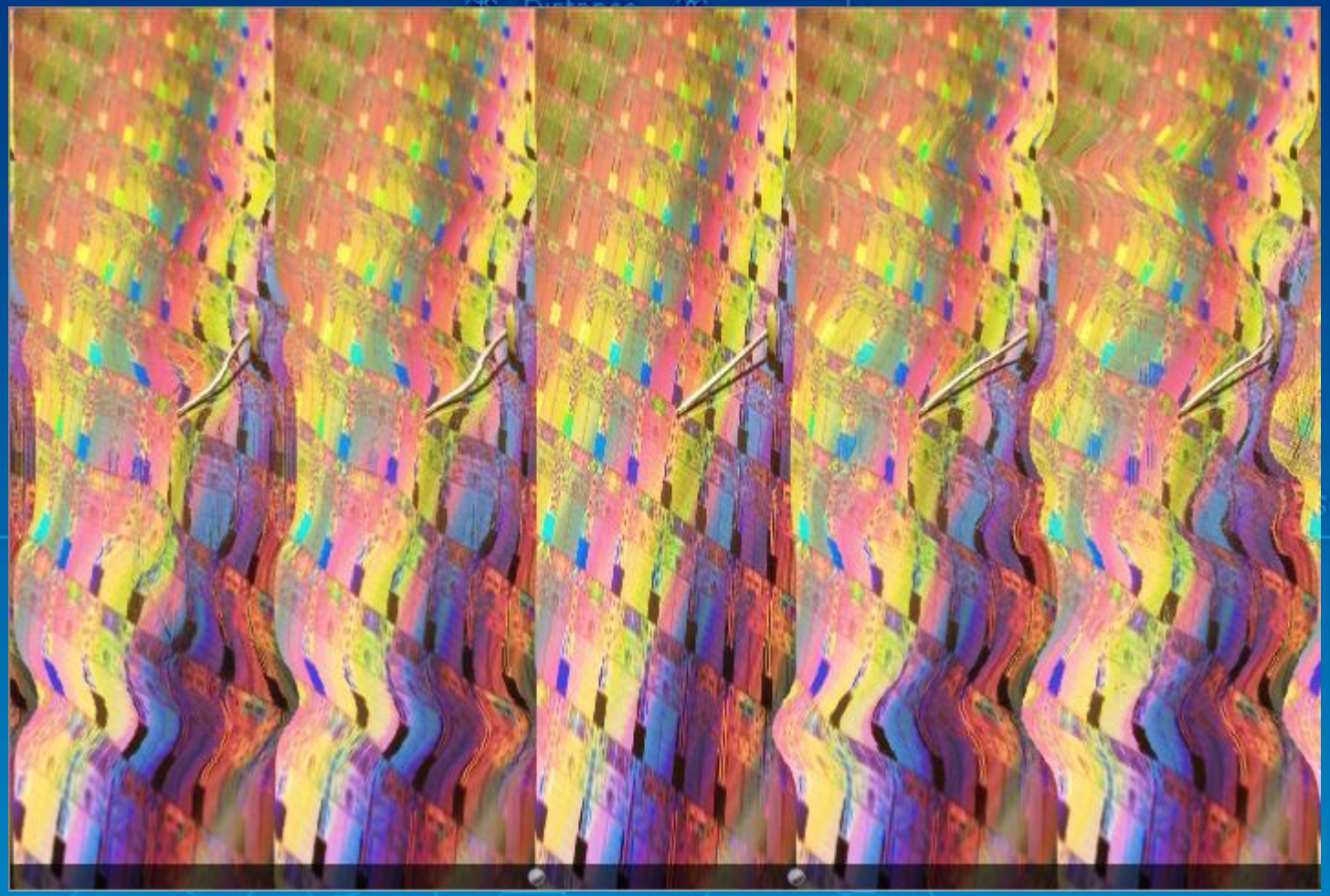
Stereogram:
An optical illusion of depth created from flat, two-dimensional image or images.

Auto-Stereogram:
A single-image stereogram (SIS), designed to create the visual illusion of a 3D scene from a two-dimensional image in the human brain.

The image is usually generated by computer by repeating a narrow pattern from left to right.



What is Auto-Stereogram?

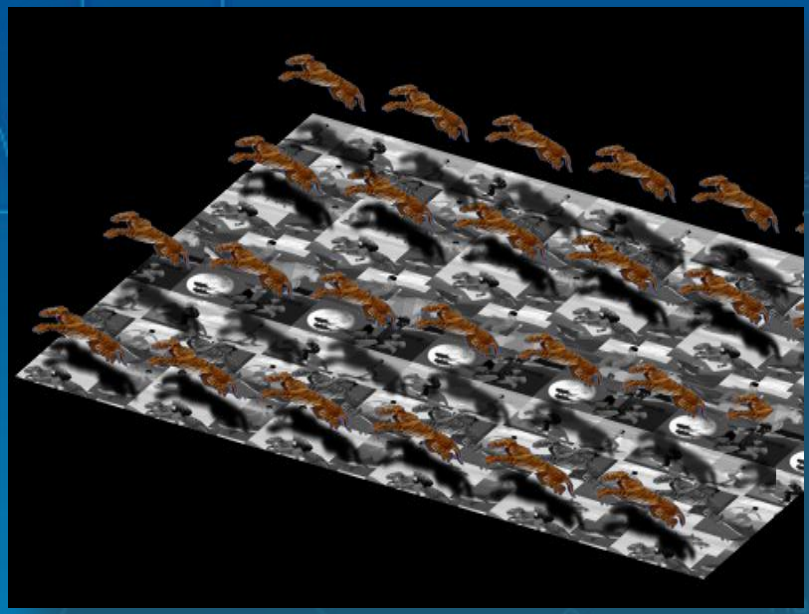


An auto-stereogram example with a 3D Intel Logo hidden behind this image.
(Designed by Me ☺)

What People will See?

"the 3D image will just pop out of the background, after you stare at the picture long enough."

If the virtual 3D objects reconstructed by the auto-stereogram viewer's brain were real, a second viewer observing the scene from the side would see these objects floating in the air above the background image:



*Images sources: Fred Hsu, March 2005

Types of Auto-Stereogram

1) Wallpaper Auto-stereogram

2) SIRDS (Single Image Random Dot Stereogram)

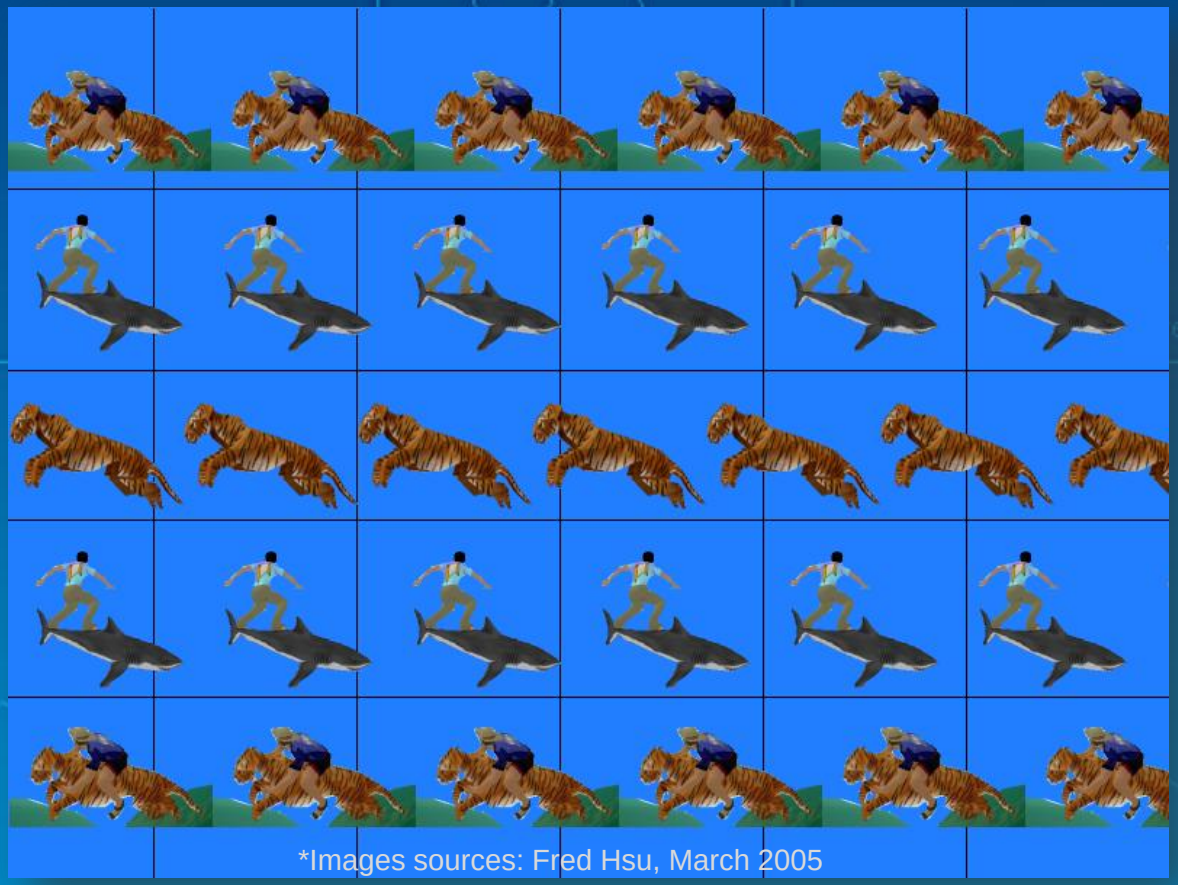
3) SIRTS (Single Image Random TEXT Stereogram)

4) Wallpaper TEXT Auto-stereogram

Types of Auto-Stereogram

1) Wallpaper Auto-stereogram

The simplest form of Auto-stereogram, consists of horizontally repeating pattern: When viewed with proper convergence, the repeating patterns appear to float above or below the background. **The 3D object it shows is very simple.**



*Images sources: Fred Hsu, March 2005

Types of Auto-Stereogram

2) SIRDS (Single Image Random Dot Stereogram)

More advanced, contains random pixel dots or complex textures.

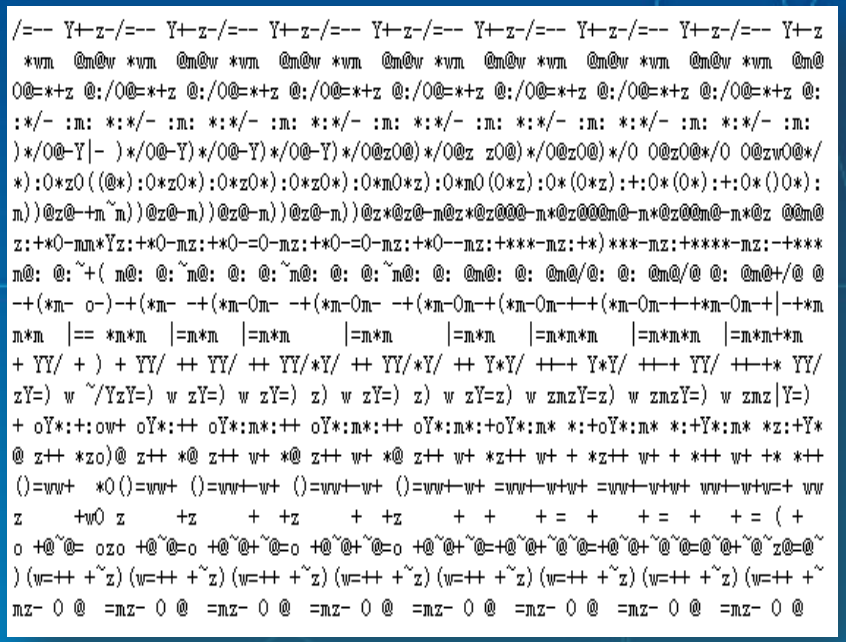
The “3D” object cannot be detected by just looking at the image itself.

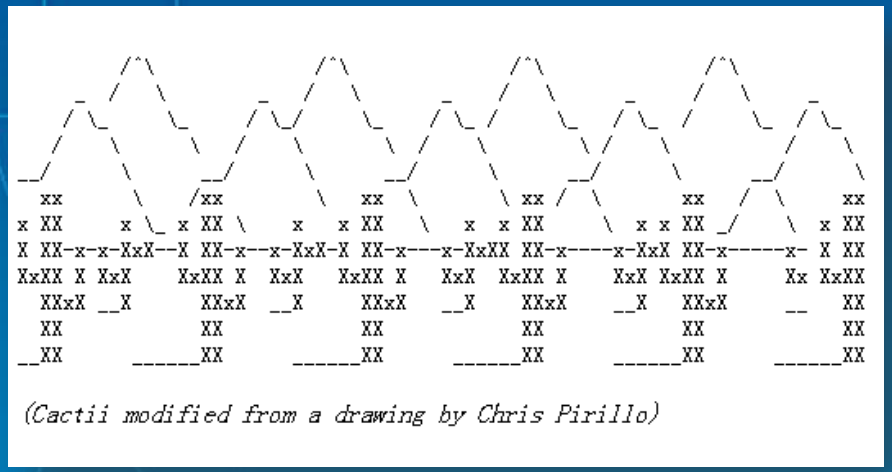
This type of auto-stereogram can be used to “store” ANY complex 3D object.

Types of Auto-Stereogram

3) SIRTS (Single Image Random TEXT Stereogram)
4) Wallpaper TEXT Auto-stereogram

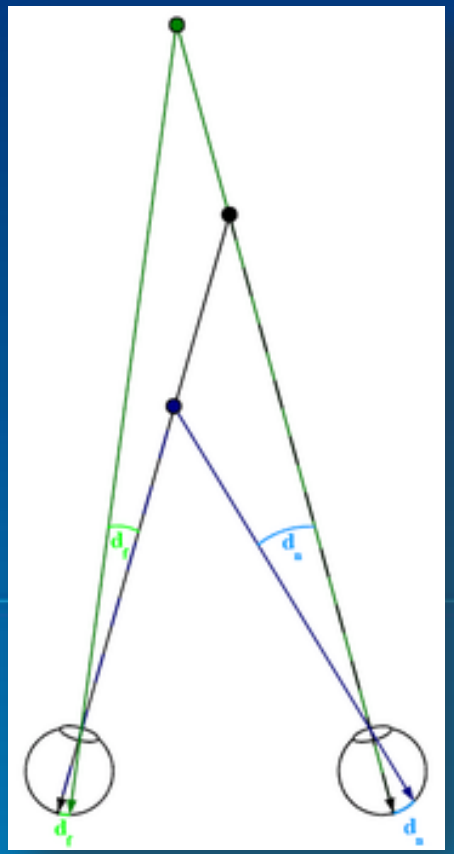
Only contains ASCII characters.





(Cactii modified from a drawing by Chris Pirillo)

Mechanisms

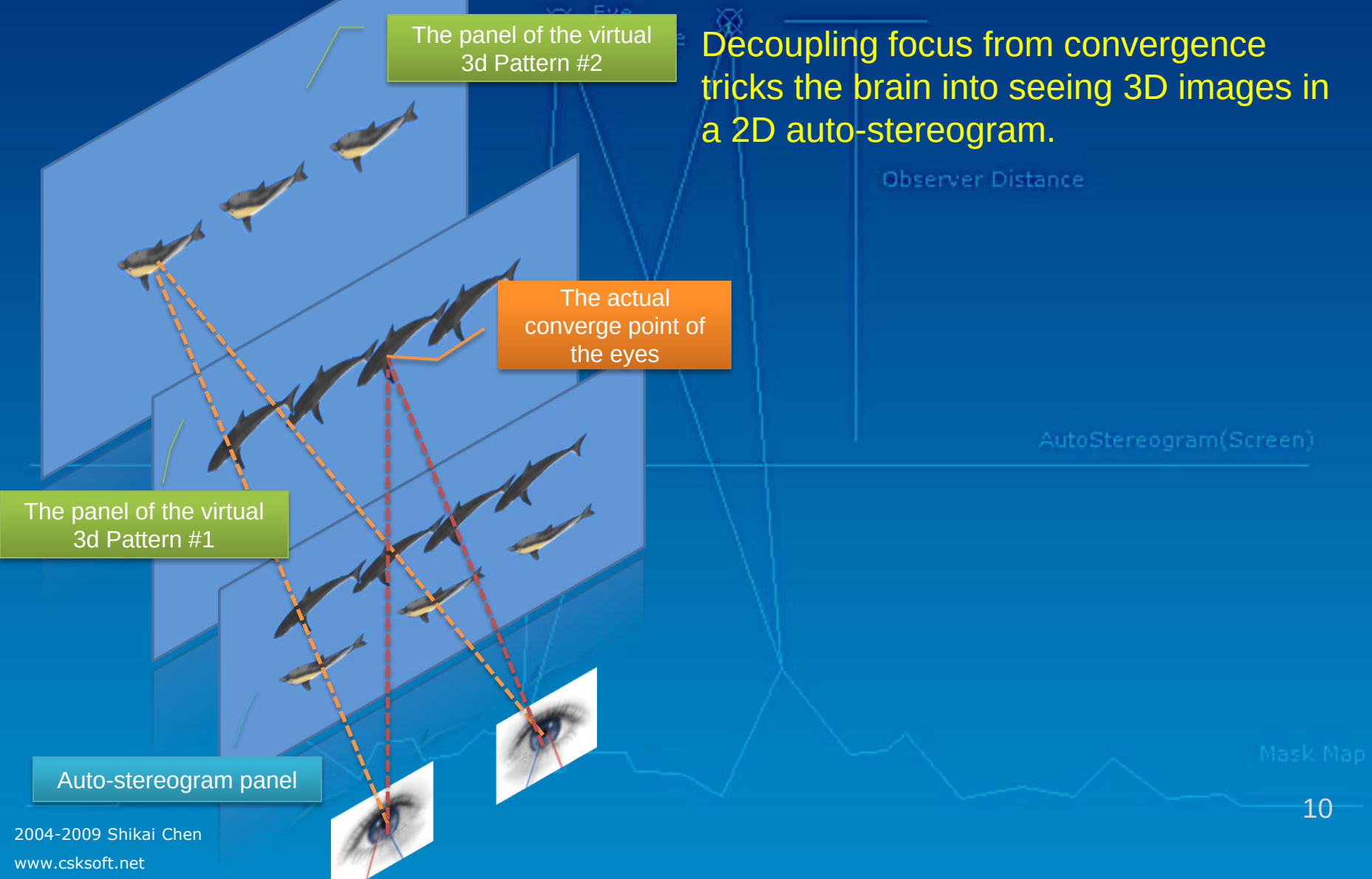


How human perceive depth(3D) info?
Binocular disparity*

the difference in image location of an object seen by the left and right eyes, resulting from the eyes' horizontal separation. The brain uses binocular disparity to extract depth information from the two-dimensional retinal images in stereopsis.

* Qian, N., Binocular Disparity and the Perception of Depth, Neuron, 18, 359-368, 1997

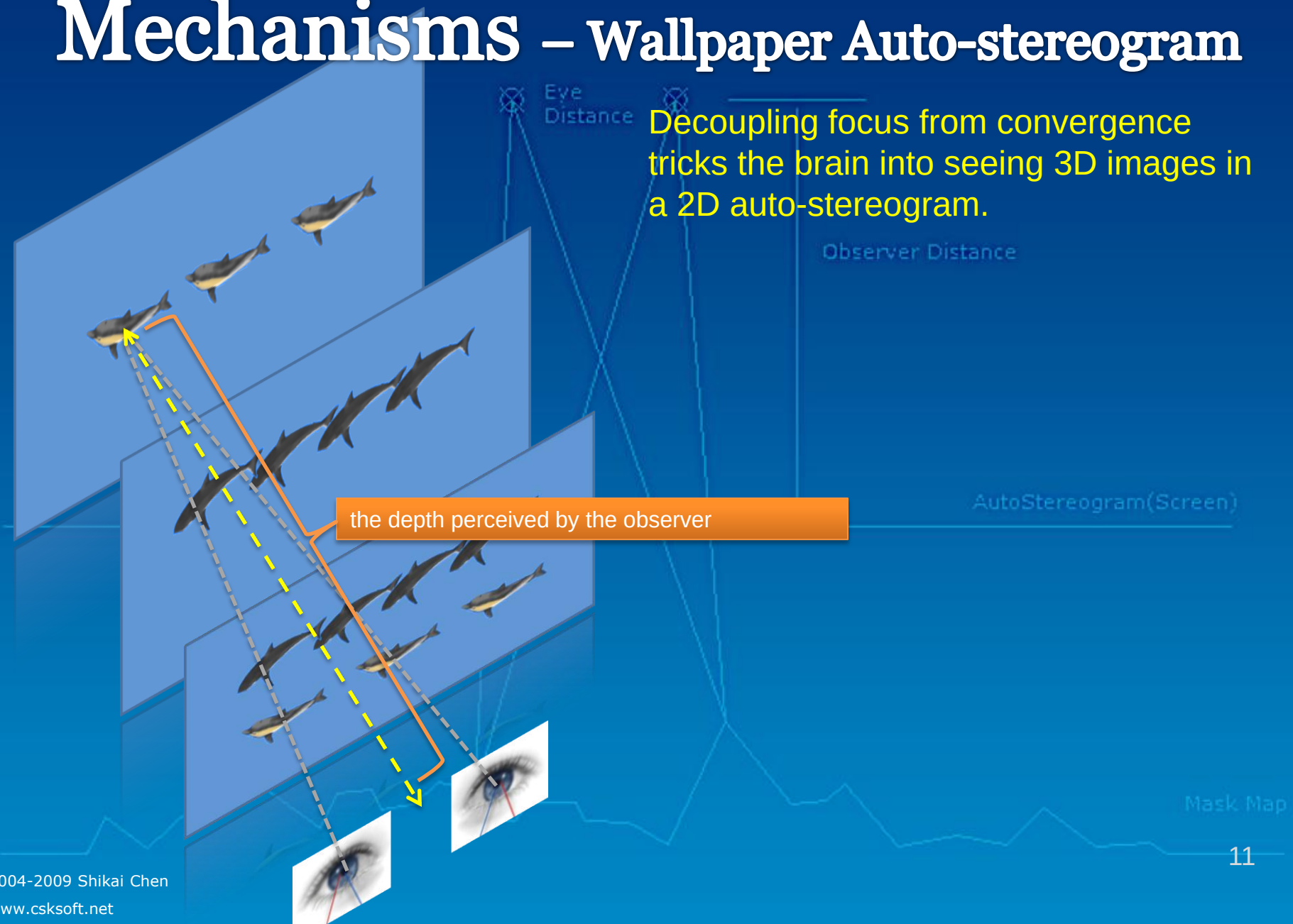
Mechanisms – Wallpaper Auto-stereogram



Decoupling focus from convergence tricks the brain into seeing 3D images in a 2D auto-stereogram.

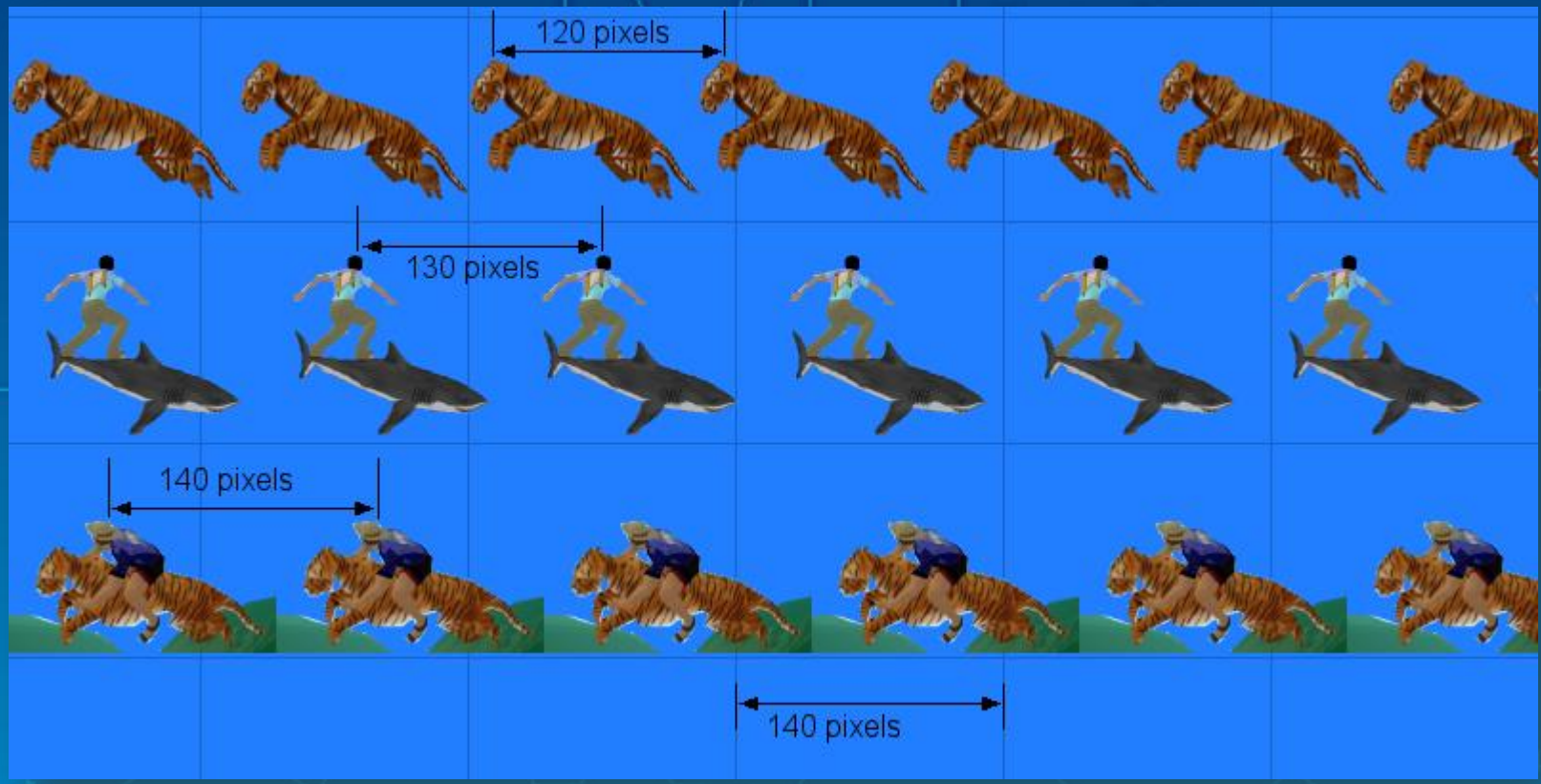
Mechanisms – Wallpaper Auto-stereogram

Decoupling focus from convergence tricks the brain into seeing 3D images in a 2D auto-stereogram.



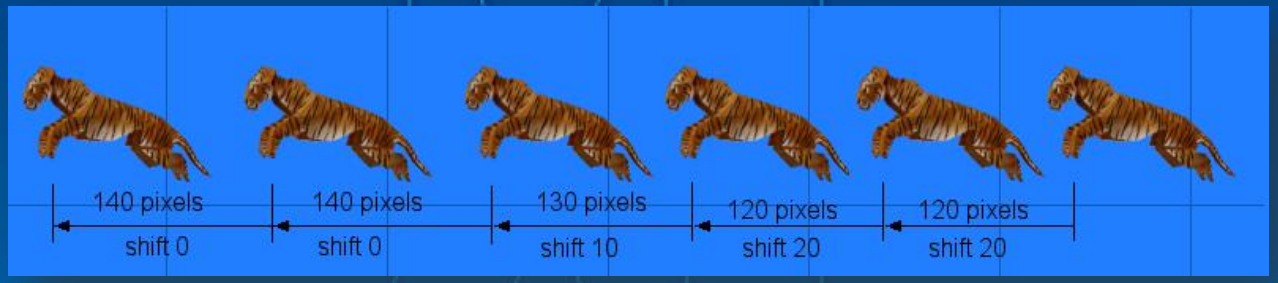
Mechanisms – Wallpaper Auto-stereogram

The further a set of icons are packed horizontally, the deeper they are separated from the auto-stereogram plane.



Mechanisms – SIRDS

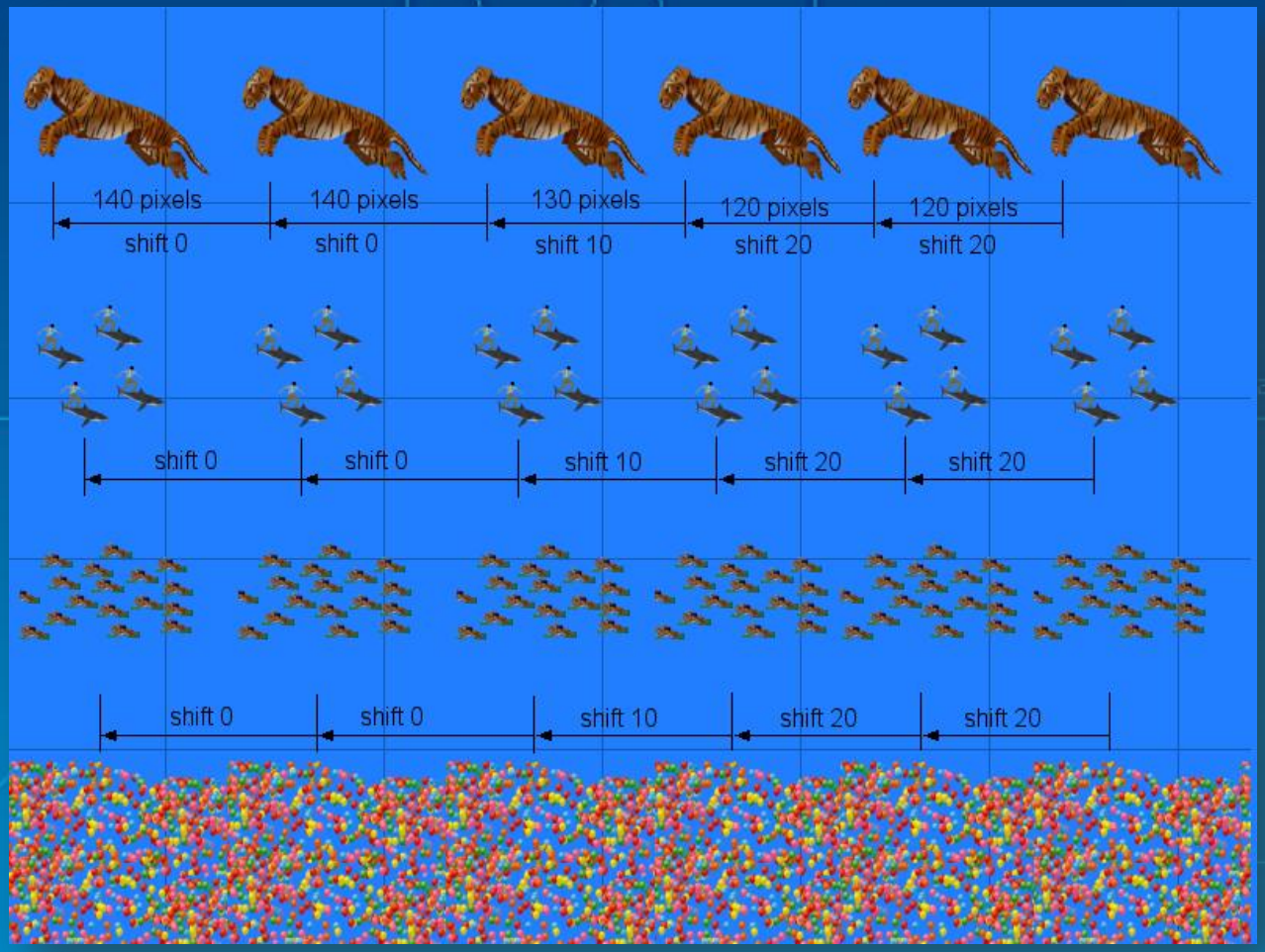
For a wallpaper auto-stereogram, icons in a row do not need to be arranged at identical intervals. And that makes a row presents these icons at different depth planes to the viewer.



Mechanisms – SIRDS

What if the icons become smaller and smaller?

*Images sources: Fred Hsu, March 2005



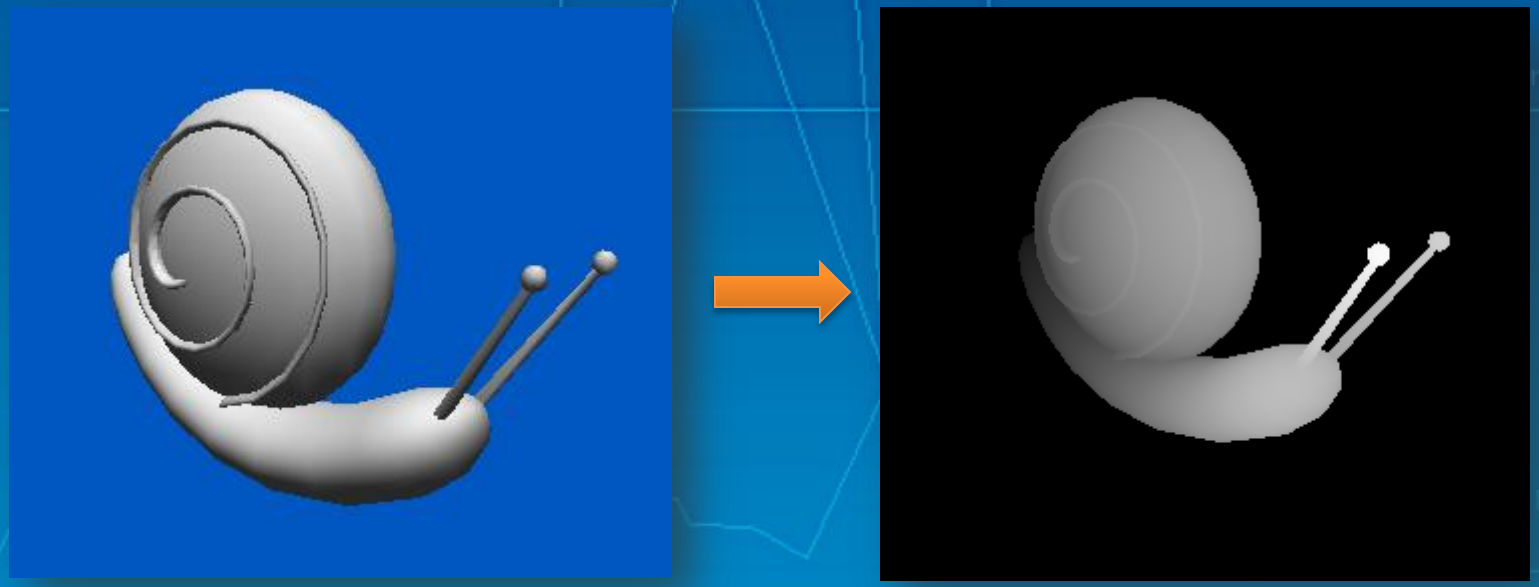
Mechanisms – SIRDS

If the icon is small enough that can be represented by a single pixel. We can use the repeating “icons” to show *ANY* 3D object.

Depth Maps

We can use a Gray-Level Bitmap to store the depth info. Such bitmaps are called Depth Maps.

For the 8-bit gray bitmap format, each pixel can record 2^8 levels depth info, The darker a pixel is, the deeper the corresponding point a viewer will feel.



Mechanisms – SIRDS

Generate the repeating “icons” based on a Depth Map.

The algorithm will scan each rows of a Depth Map and compute the separation of the “icons”.

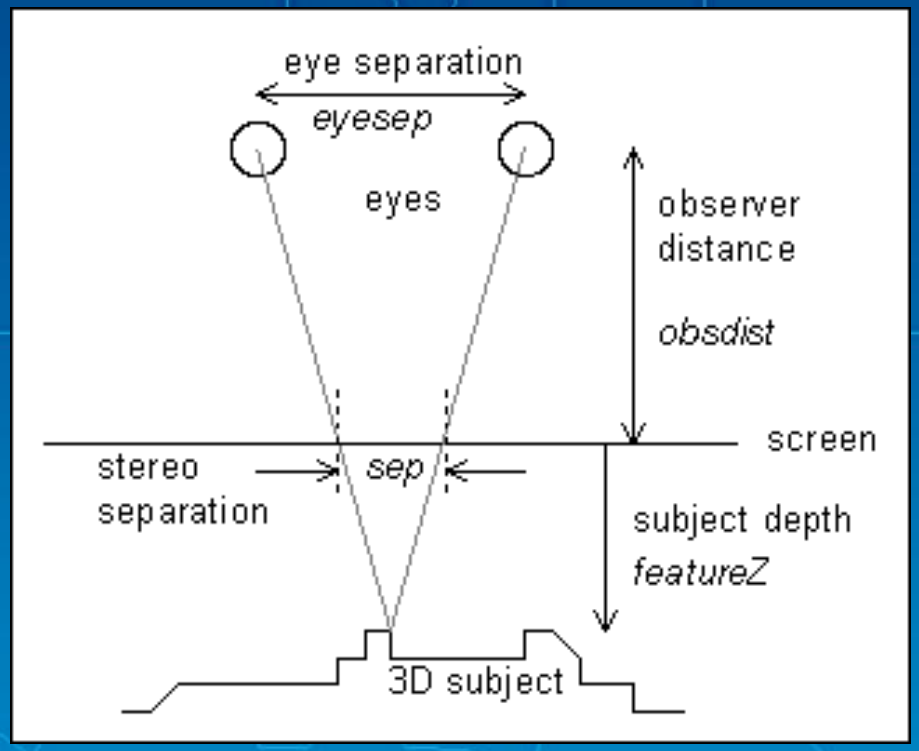


*Image source: http://www.techmind.org/stereo/stech.html

Mechanisms – SIRDS

Generate the final image.

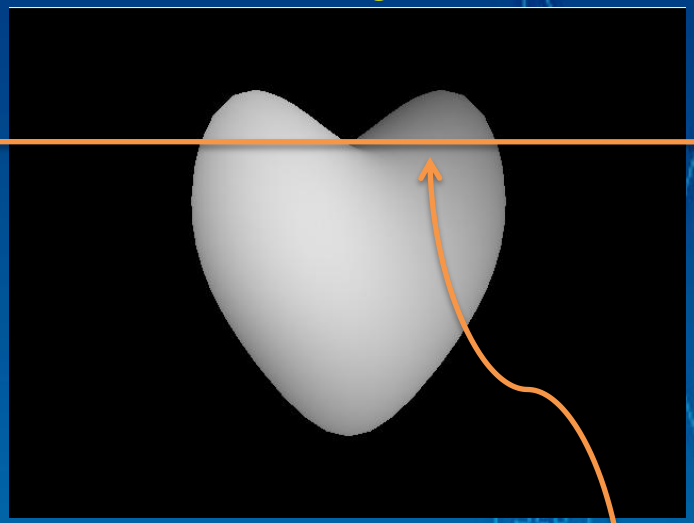
The algorithm will begin generating the image with a set of predefined “icons”(or pixels) called Pattern and then repeat filling the same pixel in a row based on the separation previous computed.

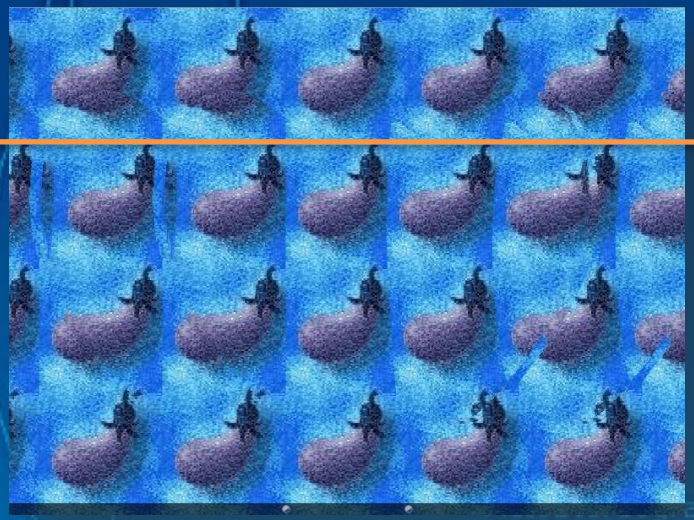
1. Start with a "depth-map" - array of z-values for each (x,y) point on the screen.
2. Working left to right along each horizontal line, for each point on the depth-map identify the associated pair of screen points and `link' them - give each a reference to its other half.
3. Again working from left to right, assign a random color or a corresponding pixel in the pattern to each unlinked point, and color linked points according to the color of their (already colored) other half.

(The actual implementation is more complex.)

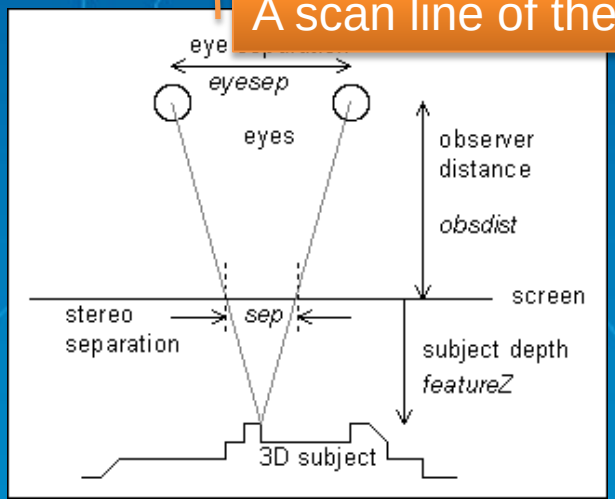
Mechanisms – SIRDS

Generate the final image.



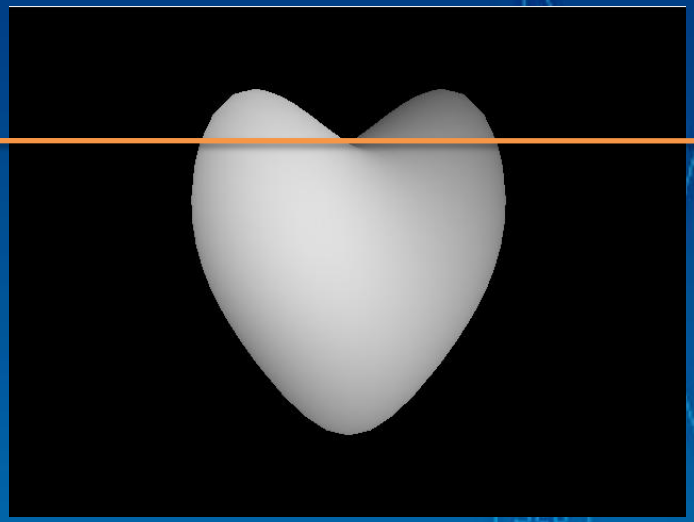


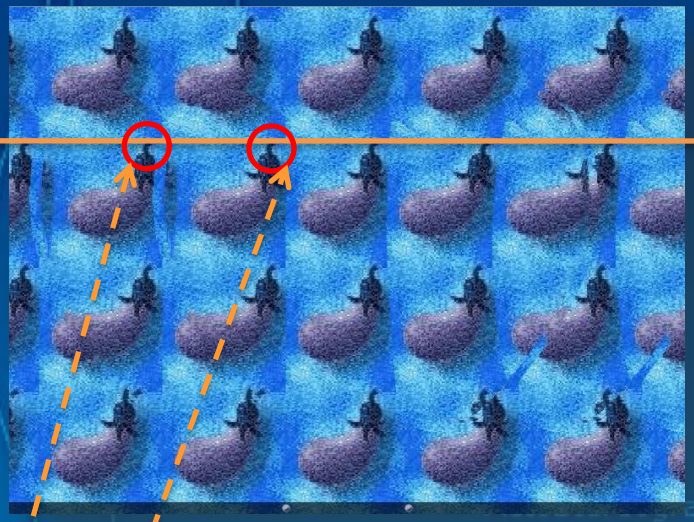
A scan line of the Depth Map and final image.



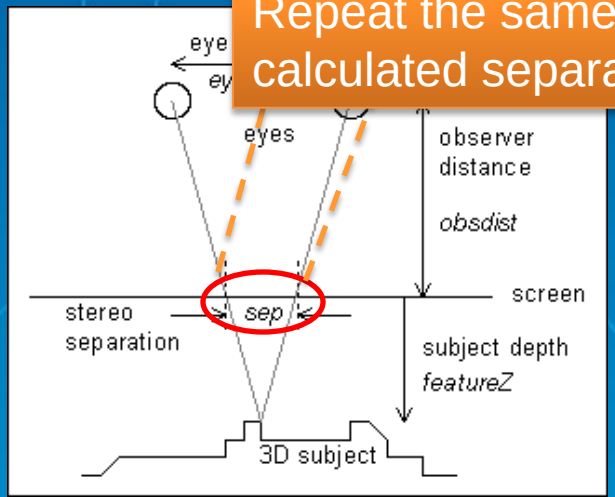
Mechanisms – SIRDS

Generate the final image.





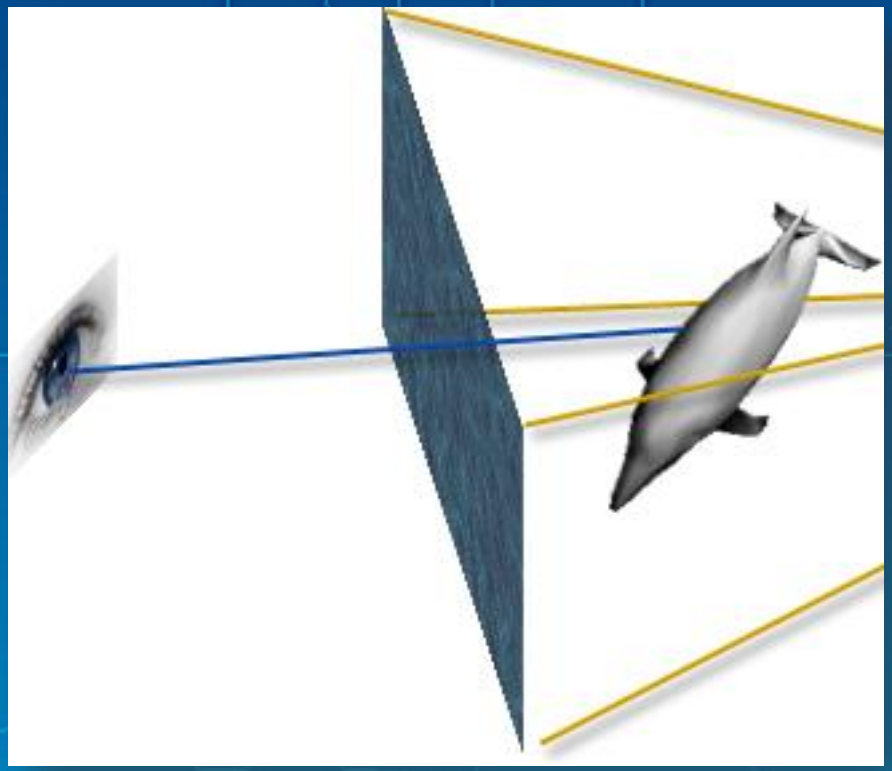
Repeat the same pixel color based on the calculated separation value.



View Tips

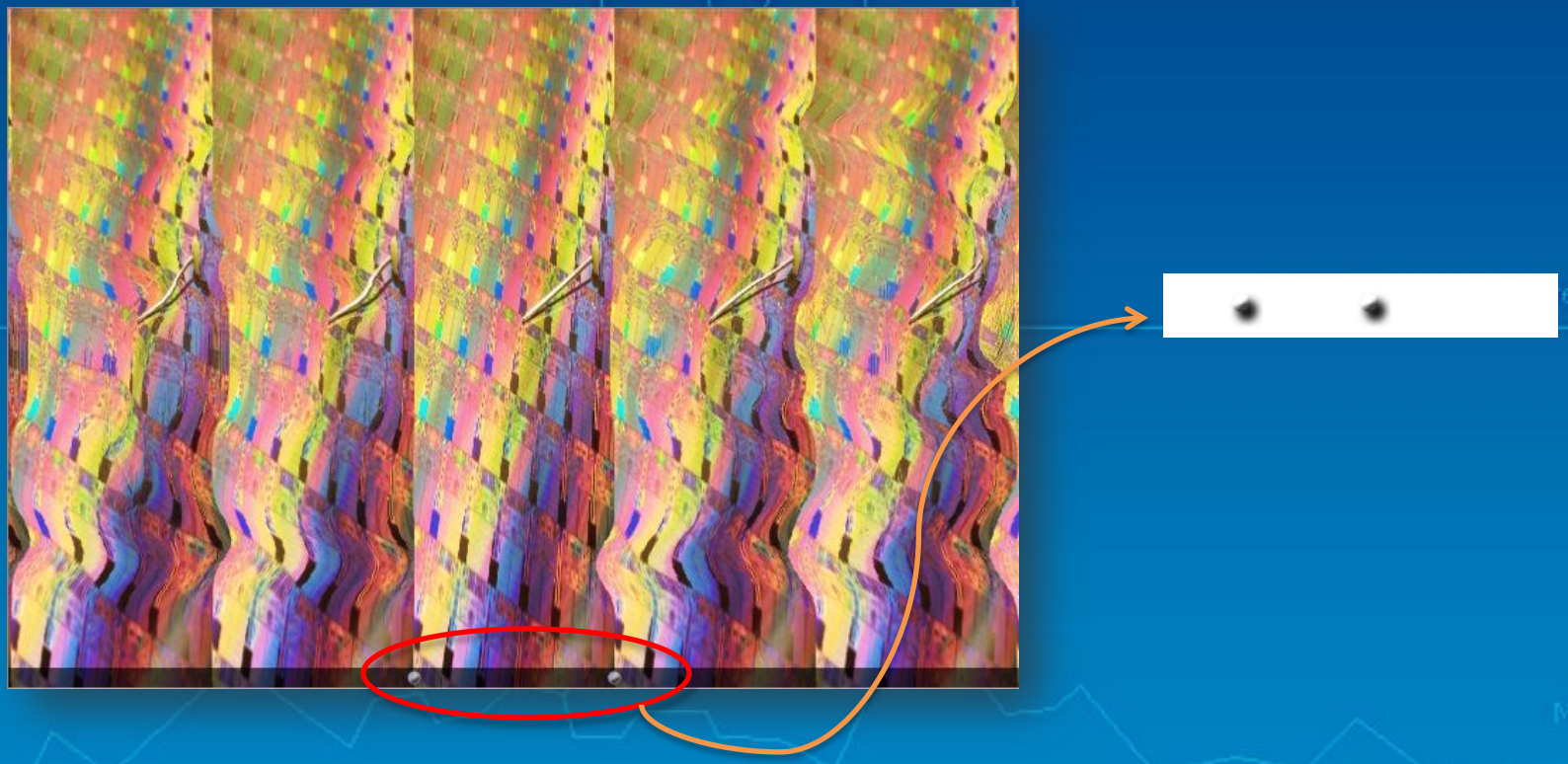
Imagine there is a real Object behind the picture…
Diverge the eye focus-> wall-eyed(diverging method)

(another types of viewing: 3d object is in front of the image -> cross-eyed)



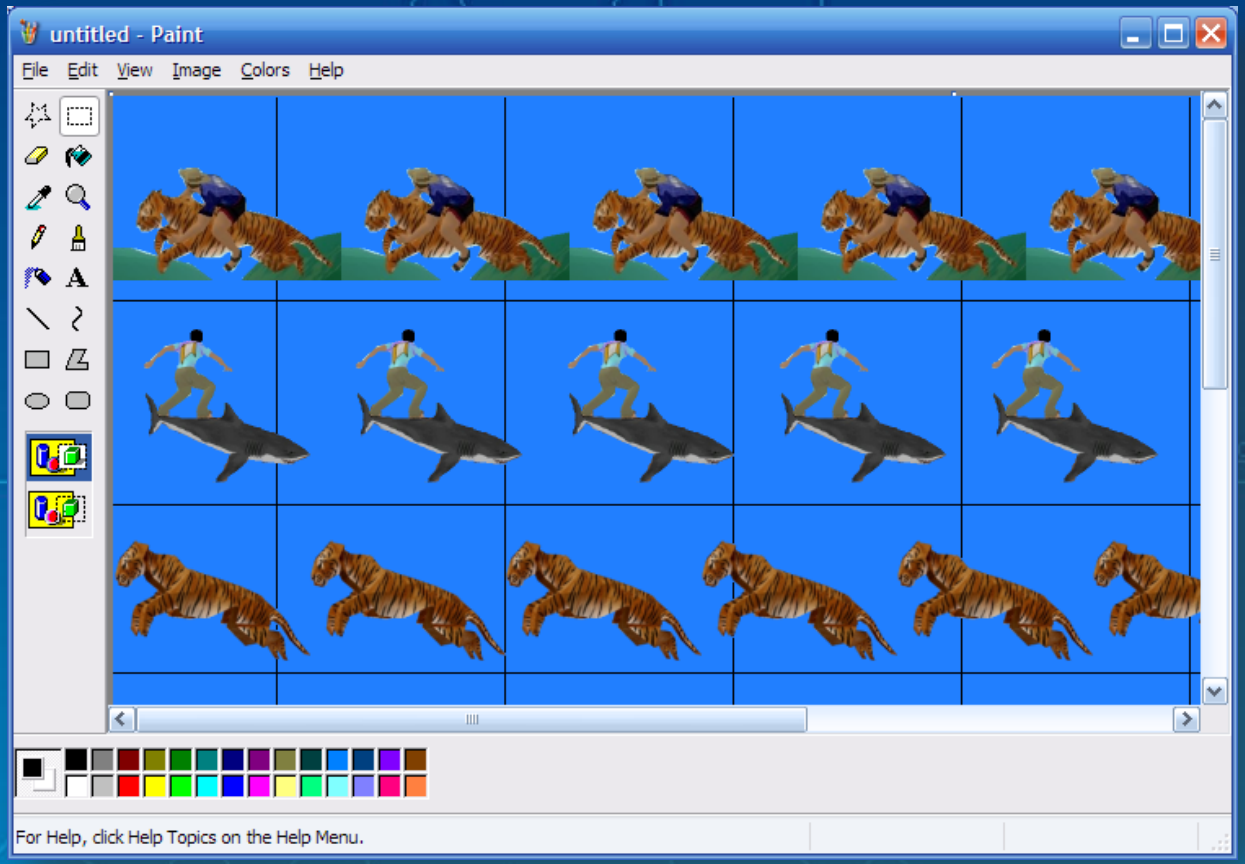
View Tips

Use the “Help dots” to help viewing:
in the process seeing "double images" typically seen when one is drunk or otherwise intoxicated. Make the two dots “become” three.



DIY – Wallpaper Auto-stereogram

Very easy. Just open a mspaint…

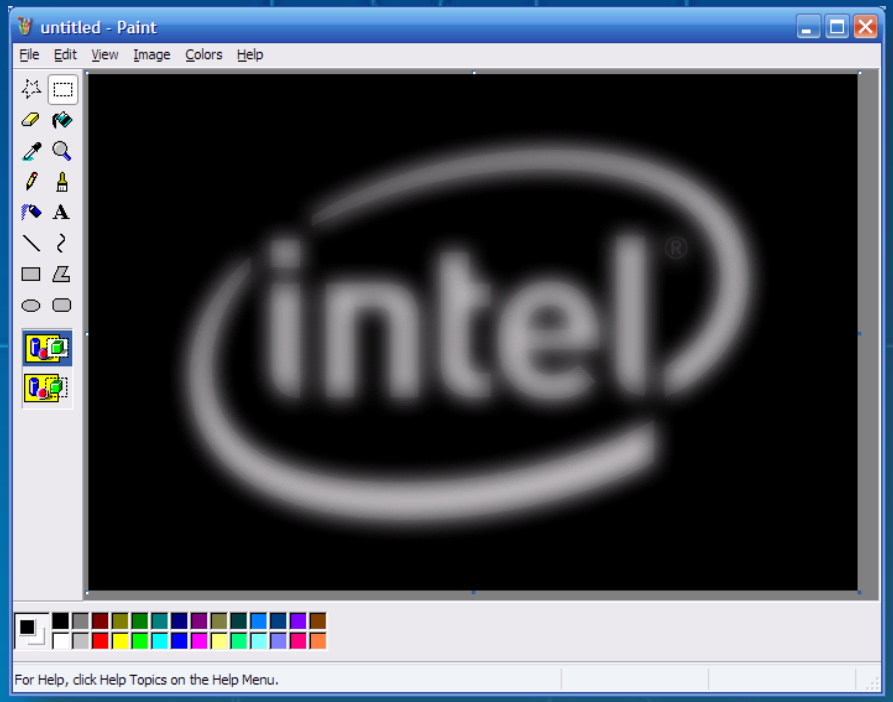


DIY – SIRDS

Resources needs:

Depth Map:

Using mspaint to generate a depth map by hand (saved as 256 gray level bmp):

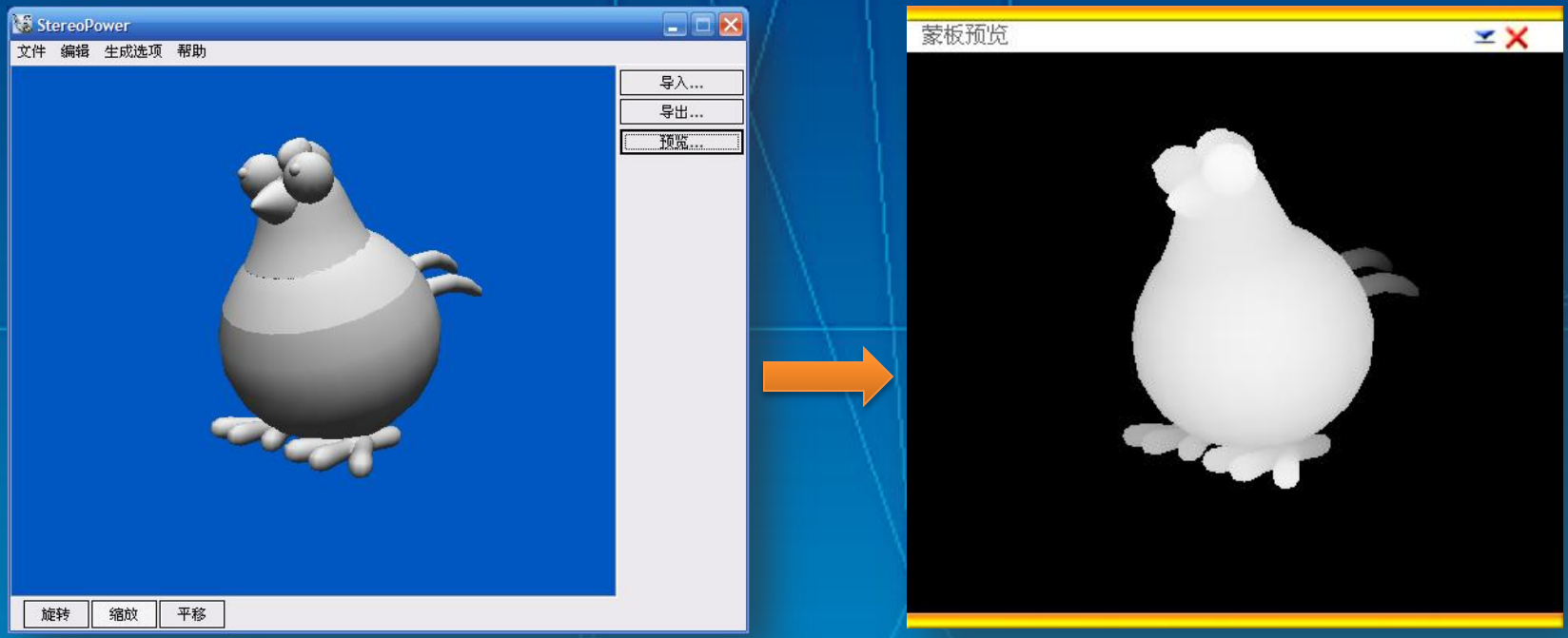


DIY – SIRDS

Resources needs:

Depth Map:

Converted from a 3ds Max/DirectX 3D model via some tool.



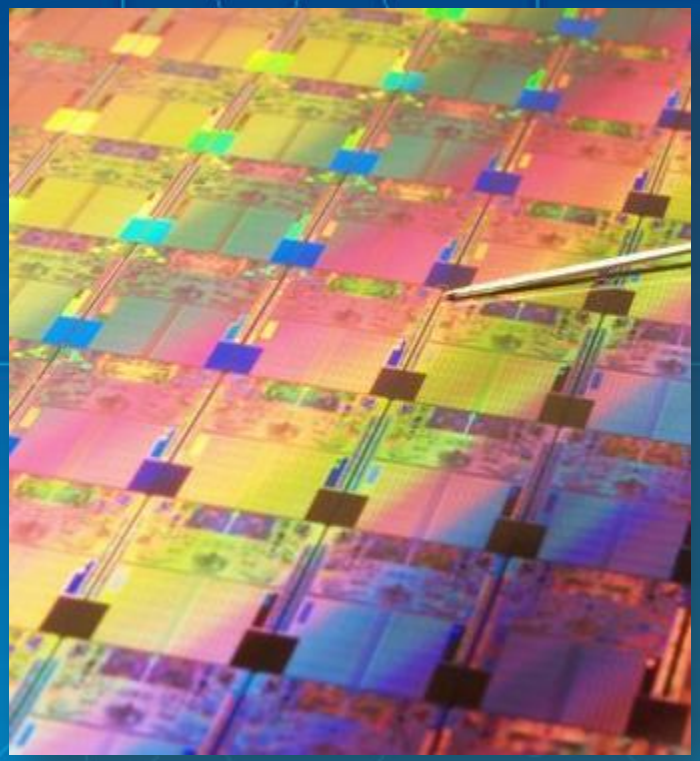
Convert a 3ds max 3d model into a depth map

DIY – SIRDS

Resources needs:

Texture Pattern:

Any images with complex texture info.



DIY – SIRDS

1. Write a simple C code…

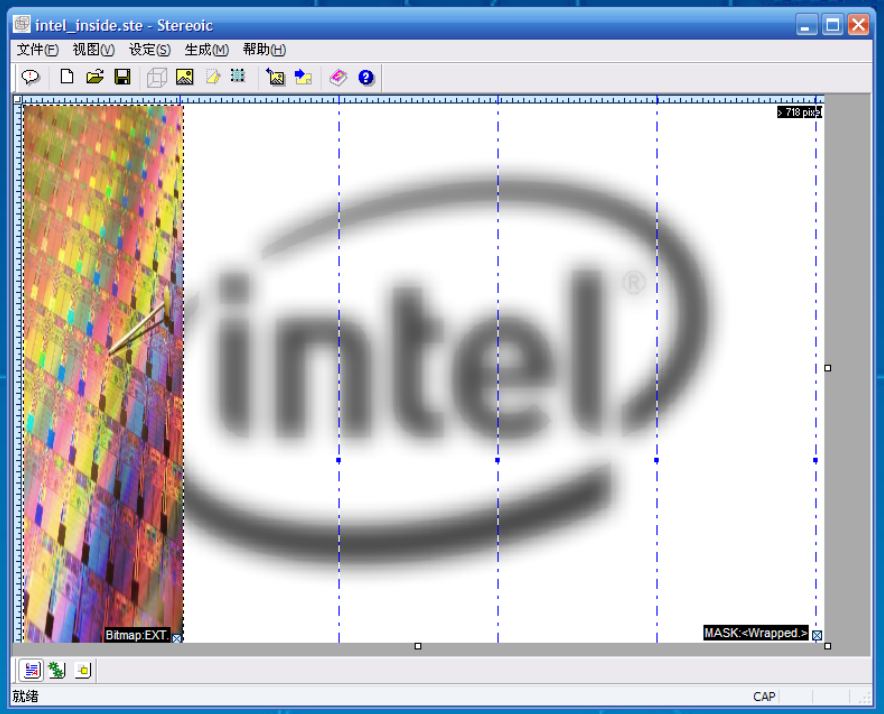
You may visit the URL for more detailed algorithm analysis and get a sample code: http://www.techmind.org/stereo/stech.html

```
void DrawAutoStereogram(float Z[][])
{
  int x, y;
  for( y = 0; y < maxY; y++ ) {
    int pix[maxX];
    int same[maxX];
    int s;
    int left, right;

    /* initialise the links */
    for( x = 0; x < maxX; x++ )
      same[x] = x;

    /* calculate the links for the Z[][] object */
    for( x = 0; x < maxX; x++ ) {
      s = separation(Z[x][y]);
      left = x - (s/2);
      right = left + s;
      if( 0 <= left && right < maxX ){
           { int k;
             for(k=same[left]; k!=left && k!=right; k=same[left])
               if( k < right )
                 left = k;
               else {
...
```

DIY – SIRDS

2. With the help of the existing tools

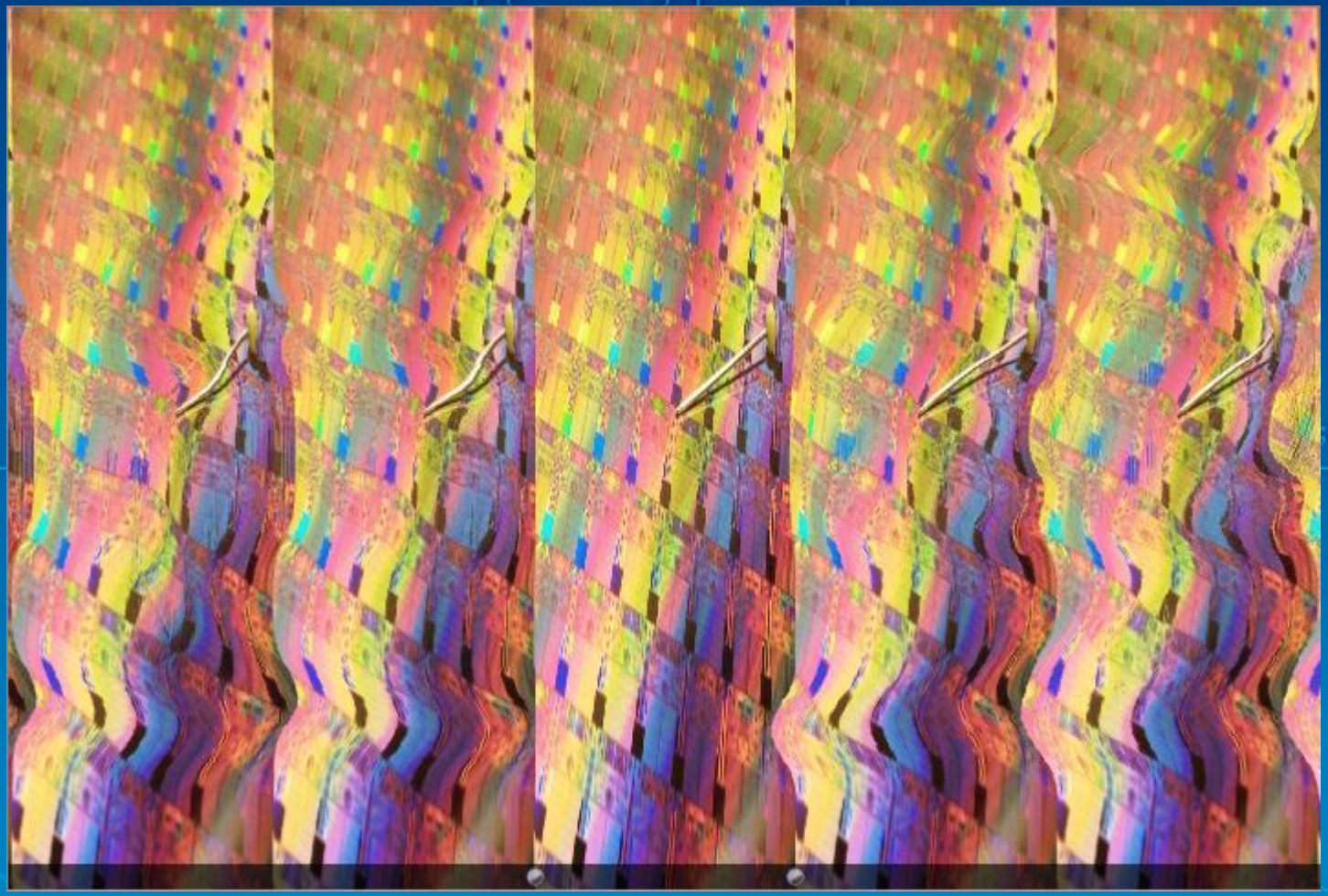
Stereogram Maker*, a visual Auto-Stereogram creator design by me ☺



*Available at:
http://www.csksoft.net/index_mainsite.asp#SubView%3D0%26ViewPos%3D50%26ViewType%3D2%26UID%3Dmainsite.site_data.ID53

DIY – SIRDS

Final Result



References & Additional Info:

Background info:

[1] http://en.wikipedia.org/wiki/Stereogram
[2] http://en.wikipedia.org/wiki/Autostereogram
[3] http://en.wikipedia.org/wiki/Binocular_disparity

Algorithm & Implementation:

[1] http://www.techmind.org/stereo/stereo.html
[2] http://www-ai.ijs.si/sirds/SirdsFaq.html

EOF
Thanks