

# IALP 2011 - 3D images\*

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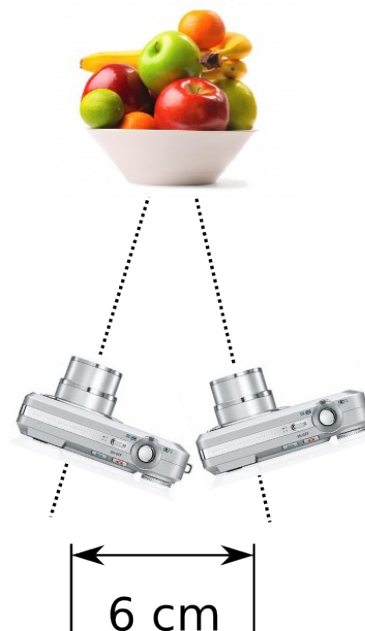


MI EET 1º ano



Making 3D pictures and movies consists of supplying different images for the left and right eye. The brain can then be fooled into thinking it is seeing something three dimensional in front.

The first step consists of taking two pictures of the same object simultaneously, with a distance between the lenses that is approximately equal to the distance between human eyes (increasing the distance will increase the 3D effect, a trick used in films such as Avatar; decreasing the distance will reduce the 3D effect). See the figure below:

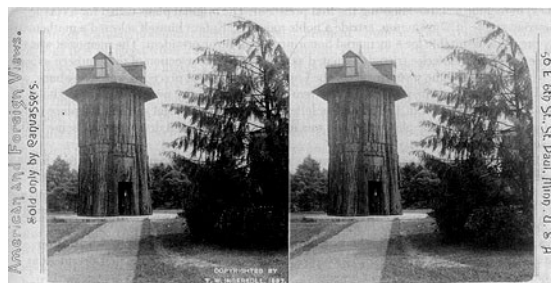
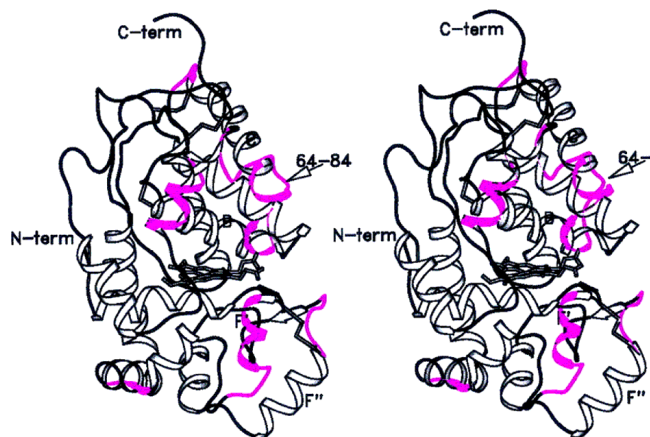


The second step is making sure the left eye gets to see only the left picture and the right eye only the right picture. There are basically 4 ways to do this: Space separation (“Stereographic”), Light-polarization separation, Temporal separation (modern 3D TVs) and Color separation.

\* Technically speaking, the images here are not 3D, but stereographic since no true 3D information is available (you cannot 'walk' around it, for instance. Nor is any modern 3D television 3D!)

## Space separation (“Stereographic”)

Separate the two images physically. For instance print them next to each other. A trained person manages to look with one eye at the left image and with the right eye at the right image. Especially used in science to see 3D structures of molecules. See the example below. Note the tiny differences between the images:

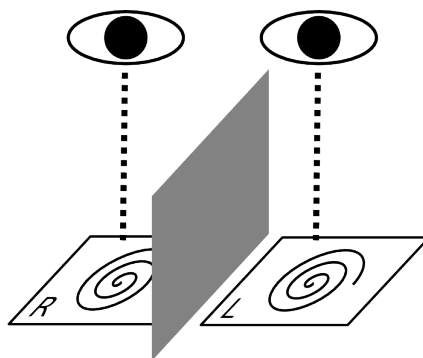


<http://www.jbc.org/content/273/4/2241.full>

<http://xroads.virginia.edu/~cap/mall/index.html>

See more examples at: <http://www.flickr.com/photos/arkane/sets/72157615813936797/>

The images can also be viewed by special equipment, such as the famous View Master. It helps to place a screen between the images, as shown below. After some experimenting, a 3D image should emerge.



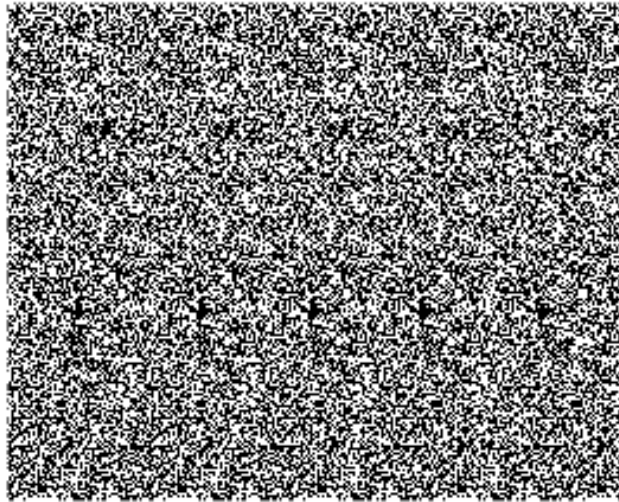
### Advantages:

- Full color.
- Simple technique (no hardware required).
- Can be printed.
- Image also makes sense without 3D effect (just look at only one side).

### Disadvantage:

- Difficult to see 3D for untrained person. Not 'natural'

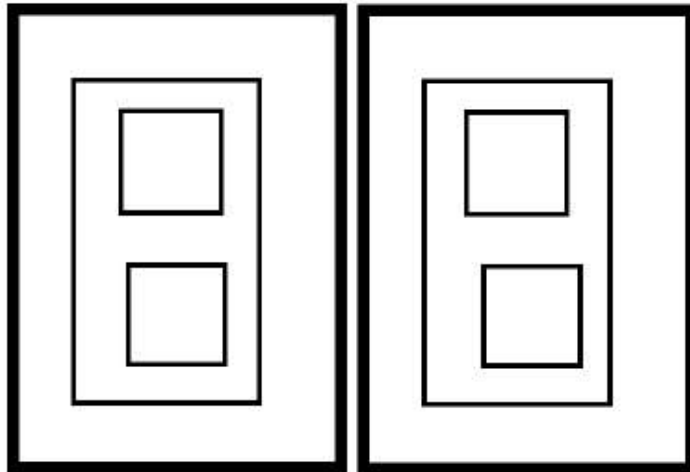
A variation on this theme is the SIRD technique (Stereo Image by Random Dots, or SRD Stereogram by Random Dots). Every dot is part of the left eye image, but also part of the right eye image. A (randomly chosen) black or white dot is repeated at a right shifted distance determined by the depth of the object. In this way a full image is constructed.



Example of a SIRD image. Try to see the ball. Obviously the trick of using a separating screen does not work for SIRDs, since both eyes have to see all the dots.

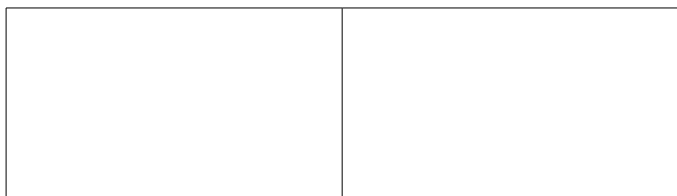
### Exercises

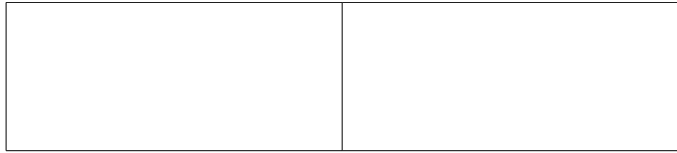
1) In the image below, which square is closer to us?



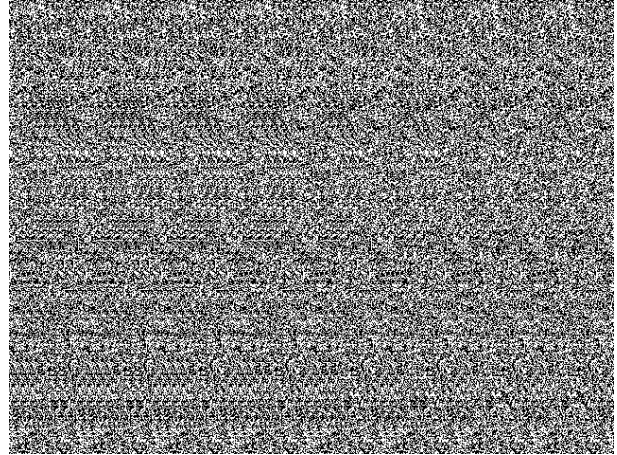
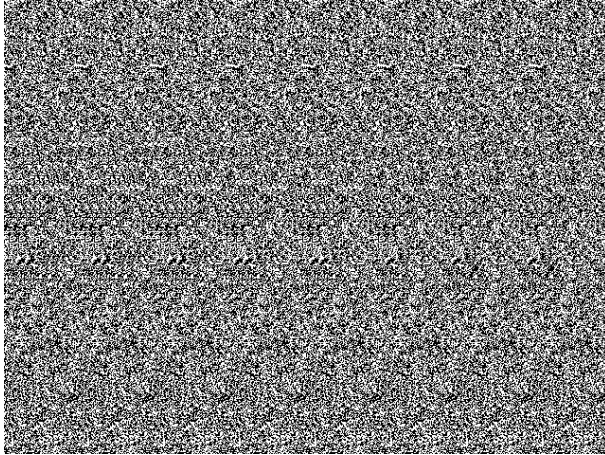
Answer:  The upper.  The lower

2) Draw a circle and a cross in the boxes below. The cross has to be closer to the viewer



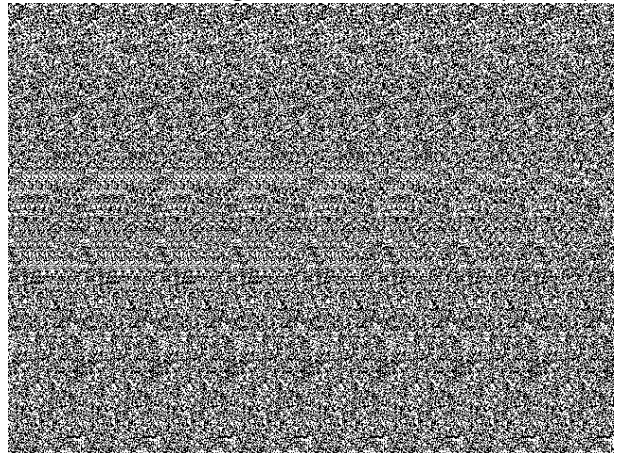
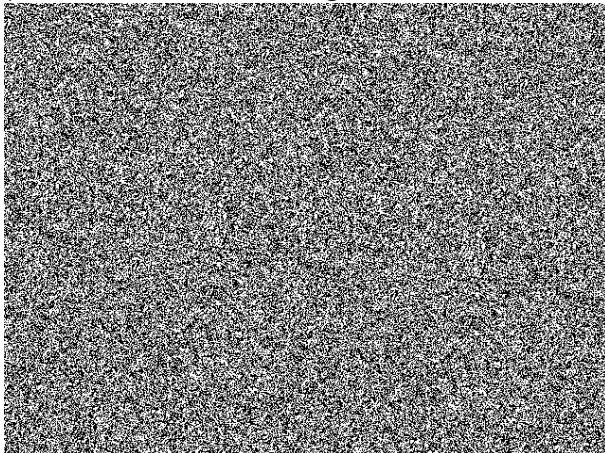


3) What is written here in the SIRDs below?



Answer:

4) Which of the two images below is a SRD and which an image of random dots (noise)?



Answer:  The left.  The right

### Local separation

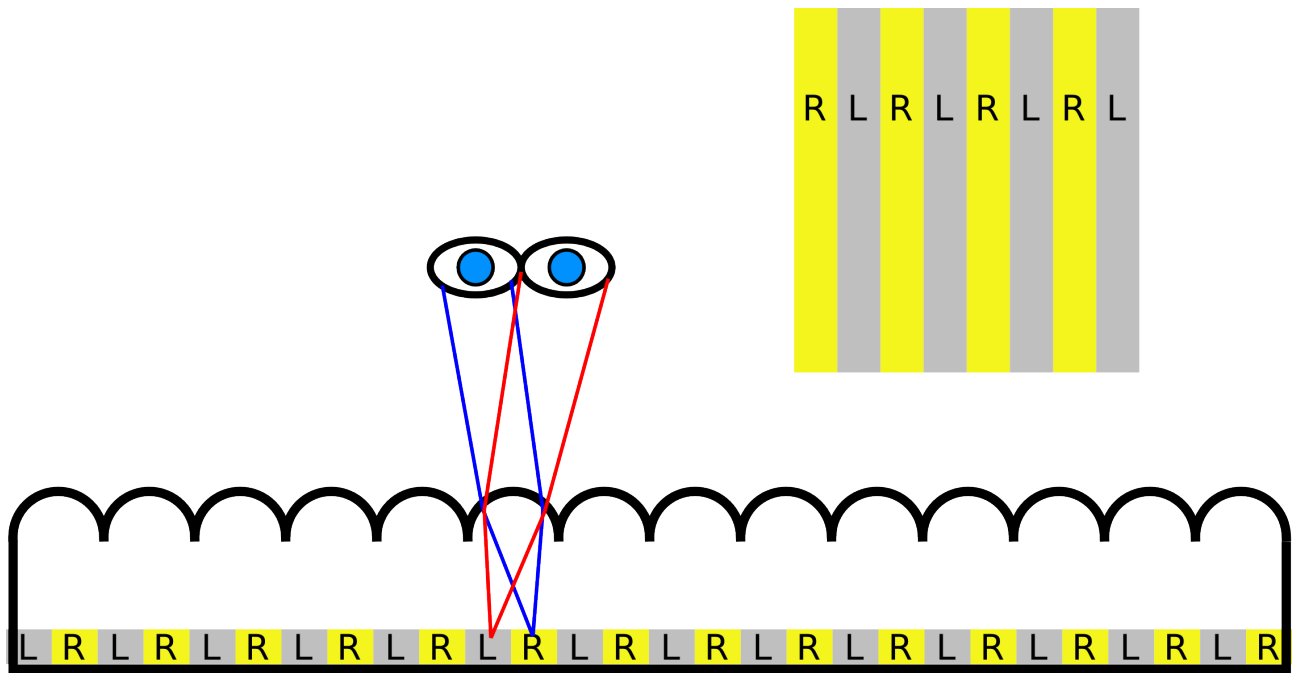
This technique is more often used to separate two different images. The left and right images are interspersed in vertical lines. On top of it is placed a plastic characteristically 'ribbed' foil that acts as lenses so that the left eye sees only the strips of the left image and the right eye only the strips of the right image, see the figure below.

*Advantage*

- There is no need for any equipment to see the image

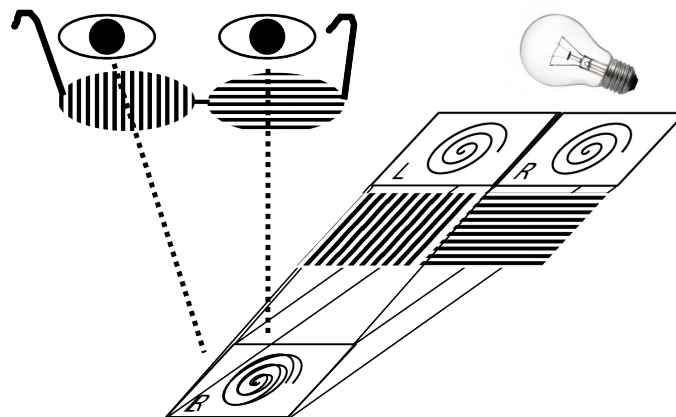
*Disadvantage*

- The quality of the image and the 3D effect is very poor.



**Polarized light**

Often used in cinemas. One image is projected with horizontally polarized light, the other with vertically polarized light. The observer is wearing glasses with polarizing filters to separate the images.



*Advantages:*

- Full color

*Disadvantages:*

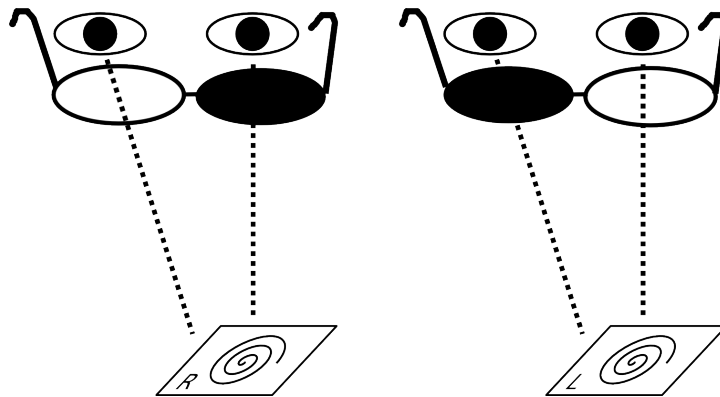
- Need of hardware (glasses and expensive dual-projectors).
- Complicated.

- Rotating head will lose 3D effect (because the horizontal polarization turns into vertical polarization, the left images becomes the right images and vice versa).
- Not printable.

Note: This technique also exists with circular polarized light instead of linear polarized. This has the advantage that rotating the head slightly will not alter the image (left-circular polarized light stays left-circular polarized, even after rotation).

### **Temporal separation. Alternating images**

Used for modern 3D televisions. The images shown on screen are alternating left and right images. Special LCD glasses are synchronized with the television screen so that the left lens only passes light when the left image is shown on the screen and the right lens is transparent when right image is shown on screen.



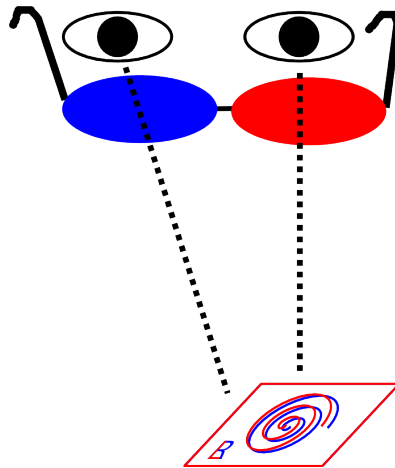
#### *Advantages:*

- Full color.
- Rotating the head (slightly) will not lose 3D effect.
- Relatively cheap. Can be done with current television technology.

#### *Disadvantages:*

- Need of hardware (glasses and television).
- Refresh rate cut in half. (A 50 Hz TV becomes a 25 Hz TV)
- Not printable.
- Glasses are powered (meaning that you can annoyingly lose the image halfway a movie!).

### **Color separation (“Anaglyph”)**



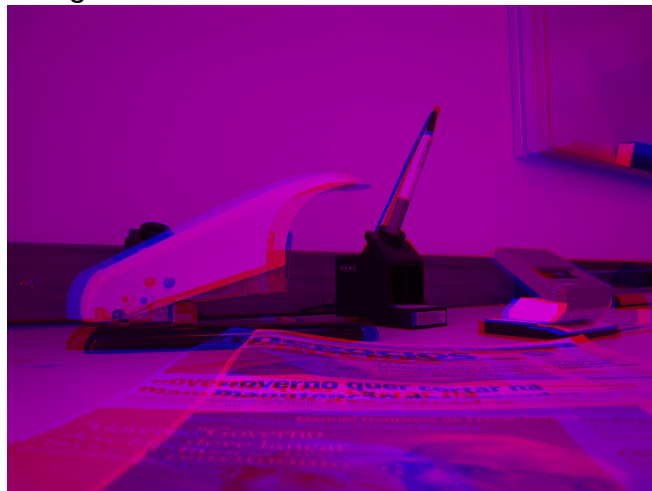
The gray-scale (!) images are converted in red-scale and blue-scale images for left and right eye respectively. The observer wears colored lenses in front of eyes to separate the two images. Two standard colors are red and blue, but also red and green is often used.

*Advantages:*

- Relatively cheap hardware. Printable.

*Disadvantages:*

- Only gray scale images.



### **Exercise. 5) Construction of 3D image**

- \* Take two pictures of a static object with the camera 5-7 cm moved in between.
- \* Copy the images to desktop and rename them L.jpg and R.jpg
- \* In GIMP combine them into a 3D image:
  - Make sure 'layers' dock is open (Windows:Dockable dialogues:Layers)
  - Load first image (File: Open as layers: R.jpg)
  - Convert to gray scale (Colours: Desaturate)
  - Add layer (Layer:New Layer)
  - Bucket-fill with blue
  - Multiply the two layers (Layers dock:Mode:Multiply)
  - Merge layers (Image:Merge visible layers)
  - Load second image (File: Open as layers: L.jpg)

- Convert to gray scale (Colours: Desaturate)
- Add layer (Layer:New Layer)
- Bucket-fill with red
- Make blue layer invisible (click on 'eye' next to layer in the Layer panel)
- Multiply the two layers (Layers dock:Mode:Multiply)
- Merge layers (Image:Merge visible layers)
- Make blue layer visible again
- Layers Mode: Addition
- Save image as COMBINED.JPG
- Look at your image with the glasses. Repeat as wanted.

Professional 3D images do not use red and blue images, because they come out 'ugly' when not seen with the 3D glasses. They also use the third channel (green) to make the image close to gray. An example is given here below:



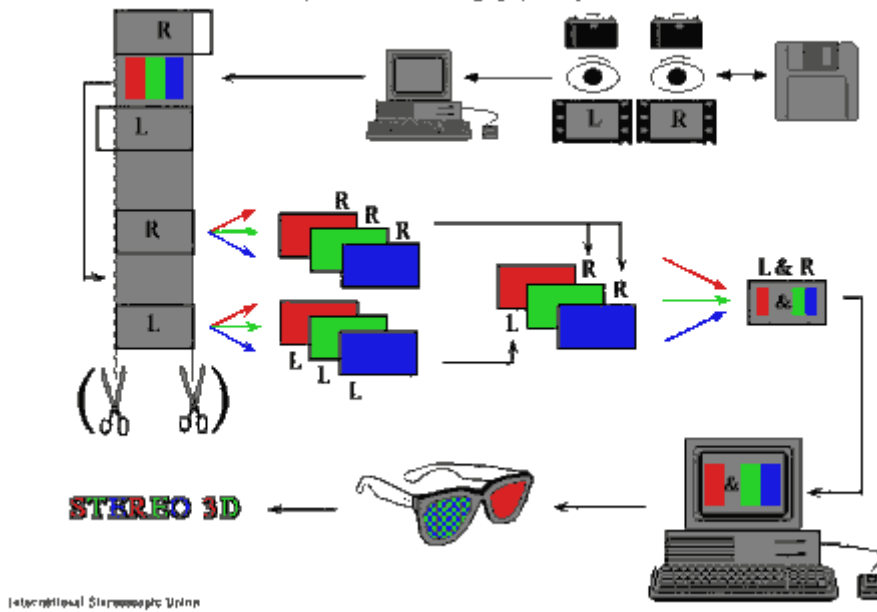
<http://imgfave.com/view/893494>

(probably this does not work on a printed version of this document!)

The way to go about this is to make the green channel equal to the blue channel, see the process below (<http://www.stereoscopy.com/faq/computer-stereo.html>)



## Computer anaglyph process



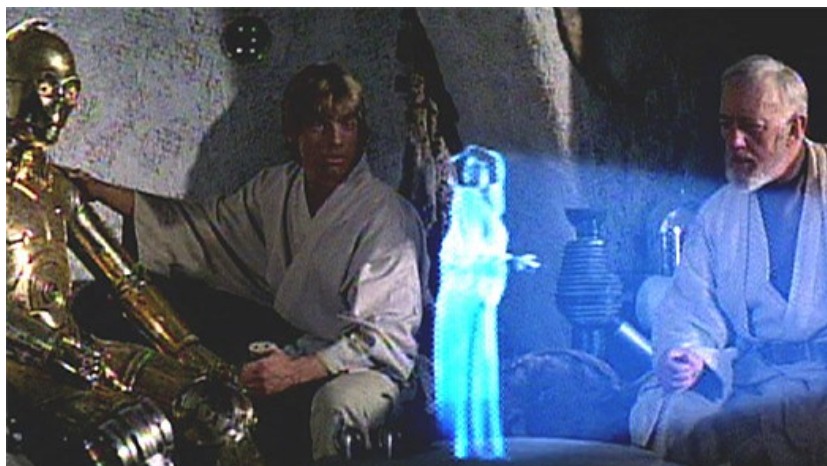
## Exercise

Construct a 3D image based on the idea above

## Real 3D

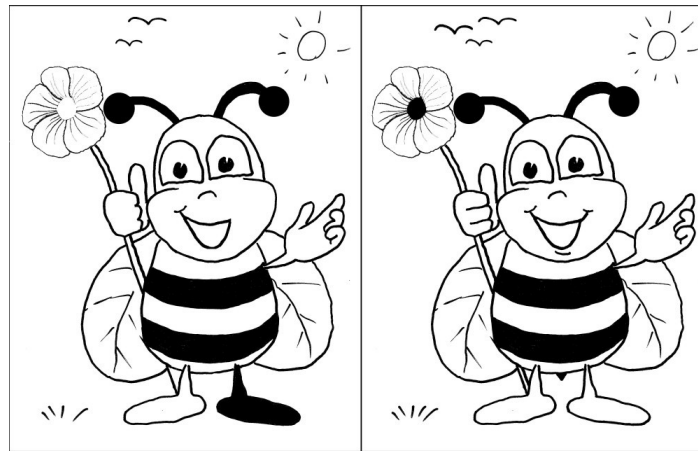


Note that the above images are all stereographic and not 3D. A static image is independently fed to the left and right eye and our brain is tricked into thinking we have something three dimensional in front of us. Real 3D images can be made with holographic imaging (like the 'seal' on some high-cost products as Windows or Euro banknotes to indicate they are genuine). In a stereographic image of a head we can never see both ears. In a holographic image we can walk around it and see either one of them.

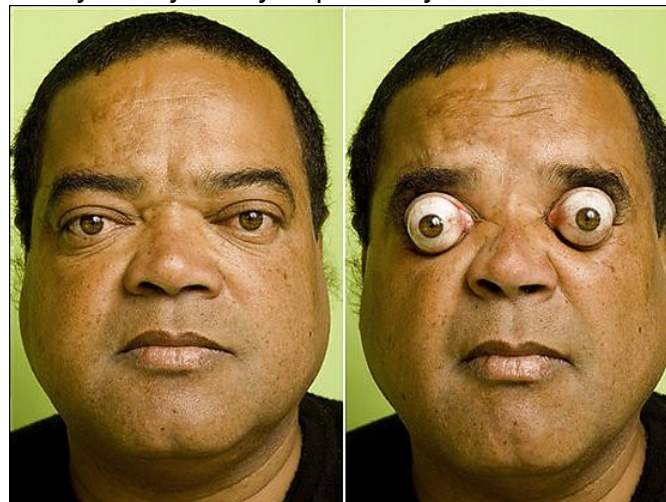


Holographic projection of Princess Leida in the movie Star Wars

And, finally, for people who manage to see the 3D macromolecule, it will also be easy to spot the 8 differences in the image below:



By now your eyes probably look like this:



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Based on:  Linux  GIMP (ImageMagick)  Ubuntu