

Laboratory task

Introduction

Autostereoscopic screens are able to display stereoscopic “3D” images without the need for any specialized headgear and can even provide motion parallax (change of image with change of viewing position). These screens, however, suffer from higher amount of crosstalk and significant loss of perceived resolution.

Tasks

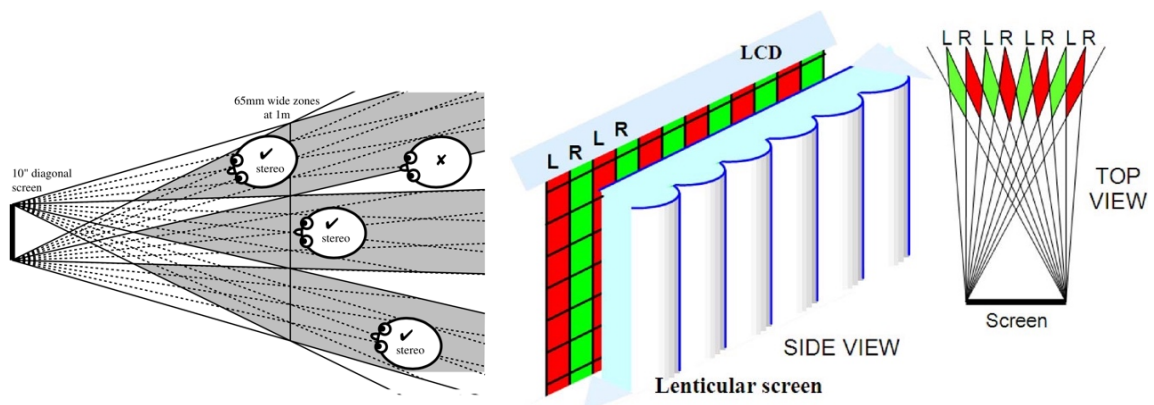
1. Measure visible crosstalk of different image mapping methods
2. Observe effects of different image mapping methods on the displayed image
3. Observe and describe artifacts caused by incorrect viewing distance

Tools used

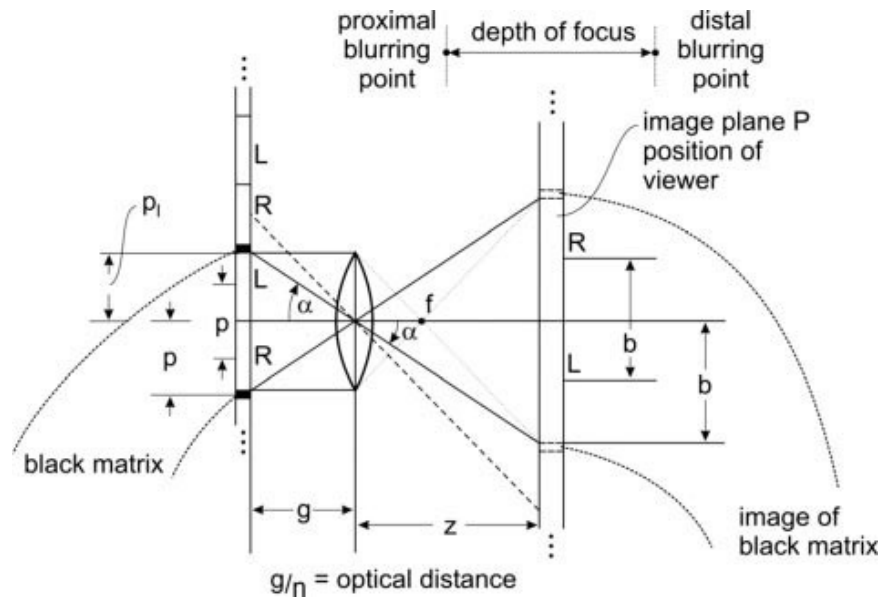
- Computer with installation of Autostereoscopic Display Tool
- Philips BDL4251VS lenticular based autostereoscopic display

Theoretical analysis

The used autostereoscopic multiview display is a type employing slanted lenticular lens technology that use refraction to focus light rays emitted by the screen itself. Displays with lenticular lenses (or simply lenticulars) make use of cylindrical lenses that project images from the FPD screen into repeating viewing zones on an image plane (at a viewing distance). In case of multiview display, a higher number of images (28 in this case) is located behind each lens and the visible views are divided into several repeated viewing zones.



Geometry of a screen with lenticular lenses is depicted in the following figure:

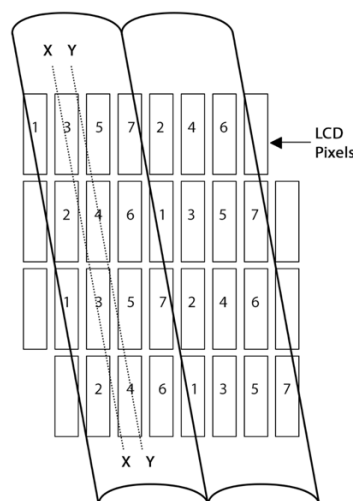


Notice there is some magnification of the pixel pitch p into a larger image pitch b on the image plane, that should be ideally corresponding with the interocular distance, which is 65 mm on average. This magnification is given by:

$$m = \frac{b}{p} = \frac{z}{g/n}$$

where b is the image pitch (interocular distance), p is the pixel pitch, z is the viewing distance and g/n is the optical distance, given by the design of the lenticulars.

The black matrix depicted in the figure above presents a problem, as it is also magnified by m at the viewing distance and is very disturbing for the viewer. This effect can be suppressed by the use of smaller pixel pitch p_1 . However, sideward movement of the viewer in the image plane causes the diminished black matrix to become noticeable. A possible solution is the use of slanted pixels in combination with vertically arranged lenticulars, which ensures there are no black lines parallel with the lenticulars. More frequently used is vertical pixels with slanted lenticulars, which has the same effect.



An arrangement such as shown this has several other advantages over simple pixel/lens parallel arrangement. The loss of resolution is distributed to both horizontal and vertical direction as opposed to full resolution in vertical direction and more severe loss in horizontal direction when vertical arrangement is used. This leads to the ability to project more views of the scene with roughly the same loss of resolution – for example a 7 view arrangement with lens width of roughly 3.5 pixels.

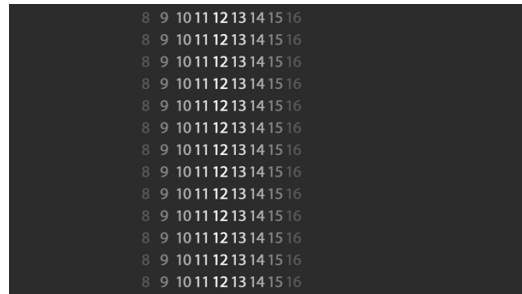
Transition between two neighboring views is made smoother with slanted pixels or slanted lenticulars. Instead of flipping into a new image, the „old“ pixels fade away while the „new“ ones simultaneously fades in, resulting in perception of an increased resolution and more pleasing viewing experience overall. Slanting also helps to eliminate moiré pattern.

The main disadvantage of slanted design is more complicated arrangement of the displayed image, so a specialized hardware or software, such as the Autostereoscopic Display Tool has to be used to interlace the individual images.

Measurement

Task 1 – Cross-talk

1. Use the enclosed user manual to familiarize yourself with the used software
2. Launch the Autostereoscopic Display Tool on your computer
3. Set the input method to Multiple Images and image mapping to Smooth
4. Load all 28 test images found in the ‘test_images/NUM_test’ folder
5. Position yourself at roughly 2m distance from the screen and observe the image displayed from different angles.
6. Fill the number of concurrently visible values displayed on the screen in the table bellow. (Example: in the image on the right there are 9 values visible).
7. Repeat steps 3-5 with the other two image mapping options (with the Cyclic view option enabled and the Original Philips option).



<i>Image mapping</i>	<i>Original Philips</i>	<i>Smooth (Cyclic view off)</i>	<i>Smooth (Cyclic view on)</i>
<i>Visible values</i>			

The filled values represent the number of views that are shown to a position in front of the screen. Ideally, only one value should be visible from a given position (always the one in the middle, the brightest), visibility of the others is caused by cross-talk.

Task 2 – Effects of different image mapping methods

1. Use the same setup as in Task 1
2. Gradually change your viewing position (move from left to right, right to left) and observe the behavior of the displayed image
3. Instead of concurrently visible values, focus on which values are visible and which do not show at all.
4. Use your own words to describe the difference between all three image mapping methods (number of values displayed, difference in brightness displayed values, effects of movement of viewing position etc.):
5. Use different set of images (either provided in 'test_images' folder or your own) to observe the effects of image mapping methods on real multiscopic images.
6. Which method gives the best results? What artifacts does each method suffer from?

Task 3 – Viewing distance

1. Load an image source of your choice. You can try other input methods as well.
2. When the image is displayed, position yourself at roughly 2 meters from the screen. You should see the desired image without any distortions.
3. Move closer to the screen and observe the effect of the change of distance on the visible images.
4. Move further from the screen than 2 meters and observe the effect on the displayed image.
5. Describe the effects of incorrect viewing distance. How is the image distorted? What are the differences between closer/further viewing positions?

References

- LUEDER, E., *3D Displays*, 2012, John Wiley & Sons, Ltd
- UREY H., CHELLAPPAN K. V., ERDEN E., SURMAN P., *State of the Art in Stereoscopic and Autostereoscopic Displays*, Proceedings of the IEEE | Vol. 99, No. 4, April 2011
- DODGSON, N. A., *On the number of viewing zones required for head-tracked autostereoscopic display*, University of Cambridge Computer Laboratory