Philips 3D Solutions

Technology Backgrounder

WOWvx for amazing viewing experiences

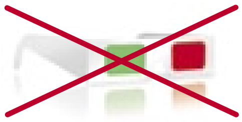
Introduction

For the past 15 years, Philips has been at the forefront of 3D display technology. In that time, we have developed the expertise necessary to provide 3D quality both for specialized and mass-market applications. In this backgrounder, we will show you how 3D technology works and explain why the approaches of Philips 3D Solutions are particularly effective.

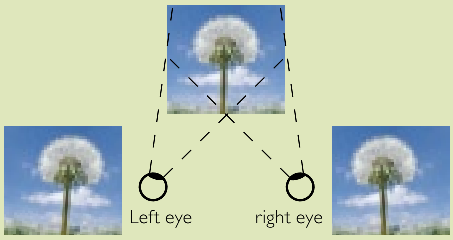
Human 3D experience

When a person views media such as photographs and television in 2D, each eye gathers essentially the same information. In other words, because the image has no real depth, there is only one way of viewing it. If there is any 3D impression at all, it comes from visual clues in the image, such as perspective.

The goal of 3D displays, then, is to get a distinct image into each eye of the viewer. From that point, the viewer's brain takes over, processing each image in the same, natural way in which it processes the images it receives from the three-dimensional world.
A characteristic common to all 3D displays is the creation and display of more than one view of a scene. Formerly, viewers had to wear special glasses to discern the views. In the last few years, a number of companies, among them Philips 3D Solutions, have introduced autostereoscopic 3D displays - displays that do not require users to wear special 3D glasses.



Two different images are combined by the brain into a 3D visual experience



3D is based on the way the human brain and eyes work. Because the pupils of a person's eye are about 6.5 cm apart, each eye views a scene from a different angle and generates a unique image. The brain merges the images to create a single picture. The slight difference between the image from the right eye and the image from the left eye allows the brain to judge the depth. Stereoscopic vision is attained.

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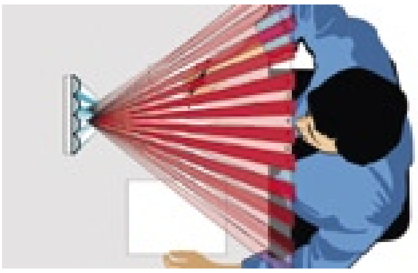
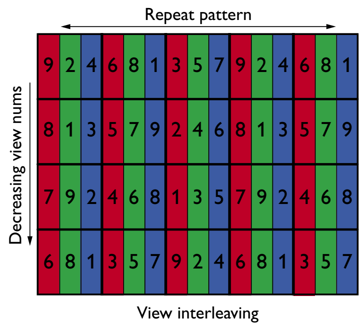




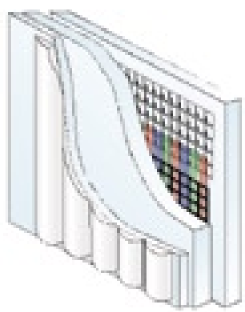
Philips WOWvx technologies

Philips has developed a suite of technologies under the name of WOWvx that promises to help professionals create an exciting viewing experience. WOWvx- based products make content richer, more informative and more entertaining for the viewer so that it almost comes 'alive'. WOWvx provides the latest innovation in signal-processing and display technology to attract the consumer's attention and is well positioned for use in a wide range of consumer and professional applications such as digital signage, gaming, simulation and video.

- Autostereoscopic 3D displays enable the 3D experience without the need for special glasses.
- Multiview slanted lenticular lens technology leads to full brightness, full contrast, and true color representation. It allows multiple users to experience 3D at the same time.
- 3D & 2D dual-mode technology for high-quality viewing of both 3D and 2D content on a single display.
- Integrated display signal processing and hardware engine gives full control over the quality and depth-effect characteristics of the picture.
- 3D file format using '2D plus depth' as a standard for 3D content to decouple content from visualization and for easy implementation in existing creation and distribution infrastructures.
- Content creation tools to support the creation of 3D content from 3D animations or games, converting stereoscopic video content, or even upgrading existing 2D content to 3D.

Multiview lenticular lens technology

A sheet of lenticules, which are transparent, cylindrical lenses, is fixed on a liquid-crystal display. The transparency of the lenticular sheet is crucial because it allows for full brightness and contrast. Other methods, such as the parallax barrier, rely on the blocking of light and therefore greatly reduce brightness. The lenticular sheet is fixed on an active matrix display, like LCD in such a way that the image plane of the LCD is at the focal plane of the lenses. Because of this, a person's eye observing the screen perpendicular to the display sees the portion of the LCD that is directly under each lens. The other eye, observing the screen from a different angle, sees a portion of the LCD that is off-center under each lens. Since the LCD under each lens is divided into subpixels, each eye sees different subpixels. To create the 3D effect, all that remains is to put the correct information on the various subpixels. Multiple views are achieved by placing the lenticular sheet over the LCD in such a way that each lens overlaps several subpixels, sending the light of each subpixel in a different direction. By repeating the lenses, entire views can be sent in different directions.



Slanted lenticular technology

A characteristic of all 3D displays is the tradeoff between pixel resolution and depth. In a scene viewed in 3D, pixels that in 2D would have contributed to high resolution are used instead to show depth. If the lenticular sheet were placed vertically atop the LCD, then horizontal resolution would drop by a factor equal to the number of views. (A nine-view vertical lenticular display, for example, would cause a nine-fold decrease in horizontal resolution and an unbalanced, elongated pixel shape.) A sheet of slanted lenticules, by contrast, distributes the resolution loss in the vertical and horizontal planes. (A nine-view slanted lenticular sheet, for example, causes only a threefold decrease in both vertical and horizontal resolution and, moreover, maintains a more balanced pixel shape.) The result is a clearer, more lifelike image. The slanting allows for the interspersing of odd and even views. Interspersing is necessary because of the gaps between each pixel on the LCD. Without interspersing, the gaps between the pixels would be magnified along with the images. Because of interspersing, observers perceive a viewing zone without gaps.

3D & 2D dual mode

Philips' WOWvx allows 2D and 3D viewing on a single display. By detecting the content type, a soft switch makes a seamless transition between the two viewing modes. In 3D mode, each lens in the display bends the light in several directions, generating a 3D image. For displaying 2D content the lens effect can be eliminated by

1. Soft-lens-switch, which eliminates the lens effect by advanced signal processing. Since the optical characteristics of the lens sheet are known, the content can be redistributed over the (sub)pixels in order to cancel out the optical working of the lenses. The result is a very crisp picture up to the native display resolution.

2. LC-lens-switch, which switches off the lens on the display when full resolution is needed for an application such as Internet browsing or text. With the LC-lens-switch in 2D mode, all pixels contribute to a unique, high-resolution image. To attain this flexibility, Philips 3D Solutions relies on a patented procedure that produces a switch in the refractive index of the liquid crystal (LC) for incident light from the display. The lenticular layer is filled with transparent LC material. In 3D mode, the LC and the lenses have different refractive indices for light. Light passing from the display through the lenses is refracted, creating the 3D effect.
For the switch to 2D mode, an electrical charge is applied to the LC, altering its refractive index, which is now exactly the same as that of the lenses. As a result, the lenticular layer becomes non-refractive; light simply passes through it.

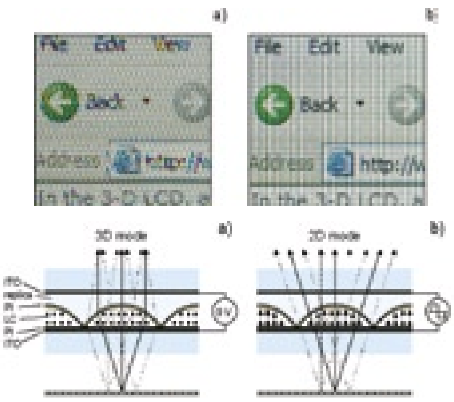


Figure 3: The lenticular-lens based 3D display can be switched on for 3D mode and off for 2D mode. a) In 3D mode, the lenses are active, and 3D content can be shown. b) In 2D mode, the lenses are deactivated, and conventional 2D content can be shown.

In order to visualize 3D data on a 3D display with high picture quality, specific processing is required. Rendering creates multiple views out of the same 3D data structure. Those views correspond to different viewing angles of the scene in the 3D video or graphics. The amount of depth, as well as the positioning of the depth in front of or behind the display, is determined by the generation of the views. View generation is followed by interweaving, whereby pixels from different views are combined in a special pattern that fits the geometry of the lenses placed over the display. Because the lenses are designed to completely cover some pixels and overlap others, the interweaving takes place at the subpixel level. Interweaving strongly influences the quality of the final 3D effect.

Real-time operation and high flexibility characterize the entire rendering process. On the one hand, the process can be adapted to different display designs; on the other hand, the end user can optimize the process for the environment in which the display is to be used. A rendering solution, implemented as a flexible hardware engine, is situated in the display for the best picture quality for each use scenario. Furthermore, the rendering processes different 3D data formats for a given 3D display. As a result, 3D data can be independent of the display.

2D-plus-depth format

To decouple content creation from content visualization, a 3D file format is required that can easily be implemented into existing 2D creation and distribution infrastructures. For this, Philips developed the '2D-plus-depth' format. The 2D-plus-depth format comprises additional depth information with every 2D image . The depth information indicates the position of each 2D image pixel on the Z (depth) axis in or out of the screen plane.

Figure 2: The 2D-plus-depth format is used as the 3D video format in our 3D display systems. (Top) A conventional 2D image providing 2D compatibility and 3D texture information. (Bottom) Depth map providing 3D geometry information by depth-per-pixel.

This 2D-plus-depth format offers flexibility and compatibility with existing production equipment and compression tools. It ensures 3D application performance within existing distribution mechanisms and standards, with a required bandwidth close to 2D. Moreover it allows applications to use different 3D display screen sizes and designs in the same system. Supported by various companies across the display industry, Philips has taken the lead in MPEG standardization of 3D video based on the 2D-plus-depth format.

3D content creation and visualization

Some applications today already use a 3D dataset but deliver a 2D image at the end. Philips now unlocks this content by supporting the visualization in 3D:

1.For popular 3D animation software such as 3ds Max from Autodesk, Philips provides plug-ins, allowing existing and new content to be exported in the 2D-plus-depth format. The 3ds Max plug-in from Philips 3D Solutions allows artists to save rendered frames including depth information, which can easily be converted to a video sequence that can be played back with our 3D Solutions Media Player. Depth information that normally would be discarded is retained, allowing the display to create the 3D image.

2.OpenGL applications such as computer games and design software can be visualized in real-time in 3D on the display with the WOWvx OpenGL Visualizer or Control by extracting the actual depth information provided by the application.
The purpose of the WOWvx OpenGL Control library and its API is to allow an application builder to get his OpenGL application running on a Philips 3D Solutions' 3D display with minimal effort. To this end, the Control library exports several functions in addition to the functions exported by the regular OpenGL library. These functions can be used by applications to make optimal use of the 3D display by setting the visualization parameters for the display.
The WOWvx OpenGL Visualizer transforms the output of an OpenGL application into the 2D-plus-depth format that is supported by Philips 3D Solutions' 3D display. The application itself does not need to be aware of the presence of the Visualizer. Hence, no adaptation of the application itself is required.
3.Video content can be converted into 3D video with a Philips semi-automated 2D-to-3D conversion tool. Media companies can revive their 2D content by creating 3D versions using the Philips conversion tools in post-production.
Building on the Philips image processing tradition, an artistic element in the production of 3D content from 2D can be added. The tooling is designed to fit into the regular workflow of media and post-production facilities.

4.Real-time stereo to 3D conversion technology enables broadcast of live events and sports, produced with stereo camera set-ups.
Strong growth in the number of 3D cinema theaters is currently generating a lot of interest in stereo content. For the cinema application, stereo is the natural format since the glasses are no distraction where the sole activity is watching a movie.
However, for other use cases such as in-home entertainment, autostereoscopic 3D is essential. In order to attain an efficient broadcast and storage format that is compatible with our 3D displays, real-time conversion of stereo captured content to the 2D-plus-depth format is a must. This holds especially for live broadcasts.

2D-to-3D content conversion

Building on Philips' years of experience in the area of video-quality improvement, Philips 3D Solutions has developed a special technique for converting 2D video and pictures into 3D.The heart of the technique is specialized image processing enhanced by a thorough analysis of the content of the image - the motion of objects in the video, their relationships and occlusions. The processing and analysis allow the creation of a depth value for each pixel. The continuity of the temporal aspect in pixel-accurate depth maps is also imposed and controlled. The result is high-quality, temporally-consistent 3D video.

This processing can be done in real time, eliminating the need to adapt existing content distribution for 3D. Moreover, the existing infrastructure can be used; a special module allowing the conversion is all that the system requires. Such a module, which can be based either on software or hardware, can operate in real time. For the creation of high-quality 3D content, semi-automatic tools can be used for post-processing the content. In the future, image quality will be improved further by the use of robust image-segmentation methods.

Conclusion

The purpose of 3D displays is to give users a viewing experience that is as true to life as possible. With its slanted multiview lenticular lens technology, display signal processing, 2D/3D dual-mode technology, and 2D-to-3D content conversion, Philips 3D Solutions has created innovations that are versatile and flexible and that do justice to the ability of human beings to see in 3D.

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