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The Development of 3D TV

Using Glasses Free Technology – Where is the Market?

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Abstract

The idea of stereoscopic (3D) viewing has been a part of the visual entertainment industry since the 1840's (Fehn, 2001). In the 1920's to 1950's, movie going audiences could watch 3D movies using red and green colored glasses using a technique called Anaglyphic stereograms (Klein, 2005). It was later in the 1950's that Polaroid introduced linear polarized glasses to the 3D movie going audience, allowing audiences to watch full color 3D movies (Rose, 2008). The first experimental 3D Television broadcast was on April 29, 1953 (Fehn, 2001).While 3D was wildly popular, it was the lack of a fundamental understanding of how to use the technology to make movies that didn't make audiences feel ill that ultimately pulled 3D out of the mainstream for years to come (Fehn, 2001).

Leap forward to today's visual entertainment industry, and we see a completely different 3D landscape. Technology has improved dramatically, like the introduction of circular polarized glasses that allow the viewer to rotate their head while still seeing 3D (Rose, 2008). While 3D movies are being produced at a record pace, 3D TV has become an up and coming segment in the television market. Today's 3D televisions however have one drawback; they require expensive LCD shutter glasses (Porges, 2011). This is where glasses free 3D televisions have an advantage; they do not require glasses. And, even though glasses free 3D TV technology is still new, many are seeing it as the future of television and digital display.

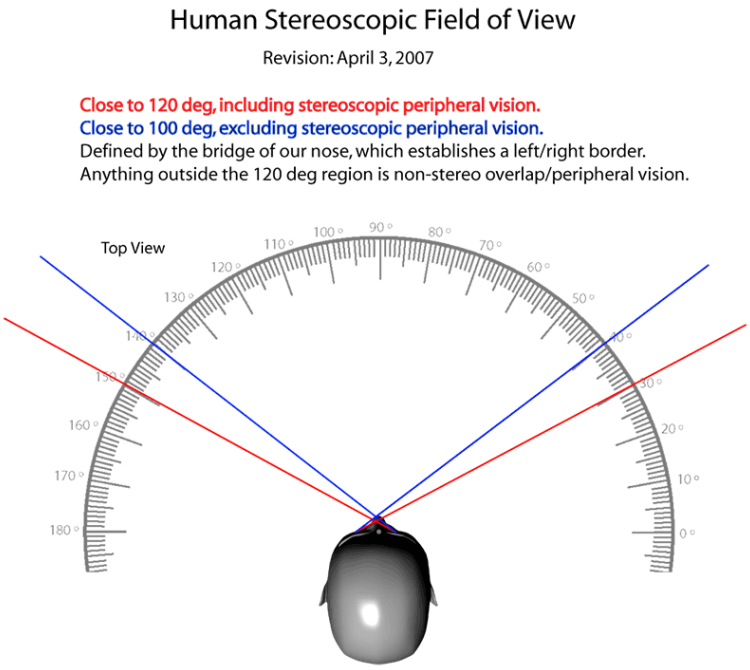
An introduction to 3D Television

How we see in 3D

Binocular vision

The reason humans perceive depth is because we have two eyes that are on average 63mm apart (David A. Atchison, 2000). This distance, known at the interpupillary distance is the key to human binocular vision. Combined the two eyes have a field of view of approximately 120° that overlap, creating the

stereoscopic field of view (David A. Atchison, 2000). As shown in the figure below, it is within this field of view that we are able to see using depth perception because each of our eyes perceives the world at a slightly different angle.

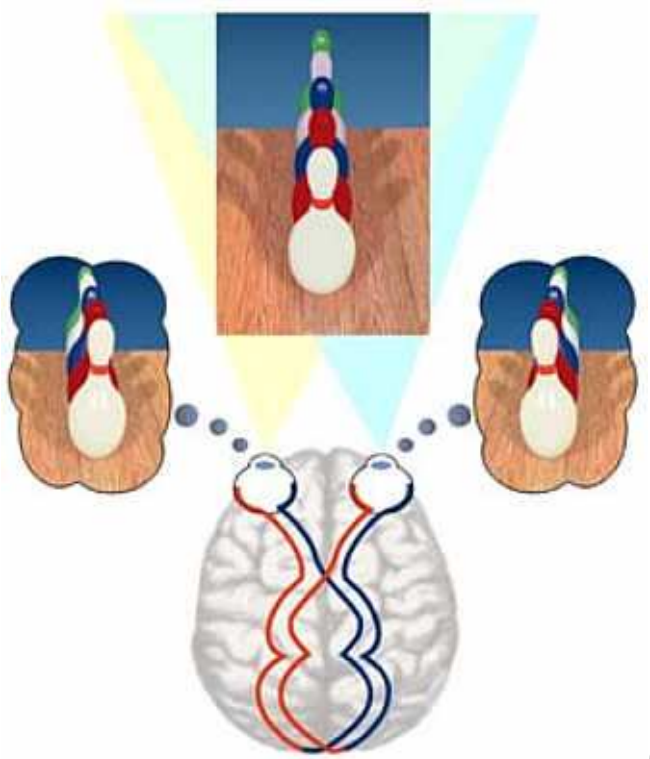


(Significant Bits, 2009)

This diagram shows the human binocular field of view.

Stereopsis

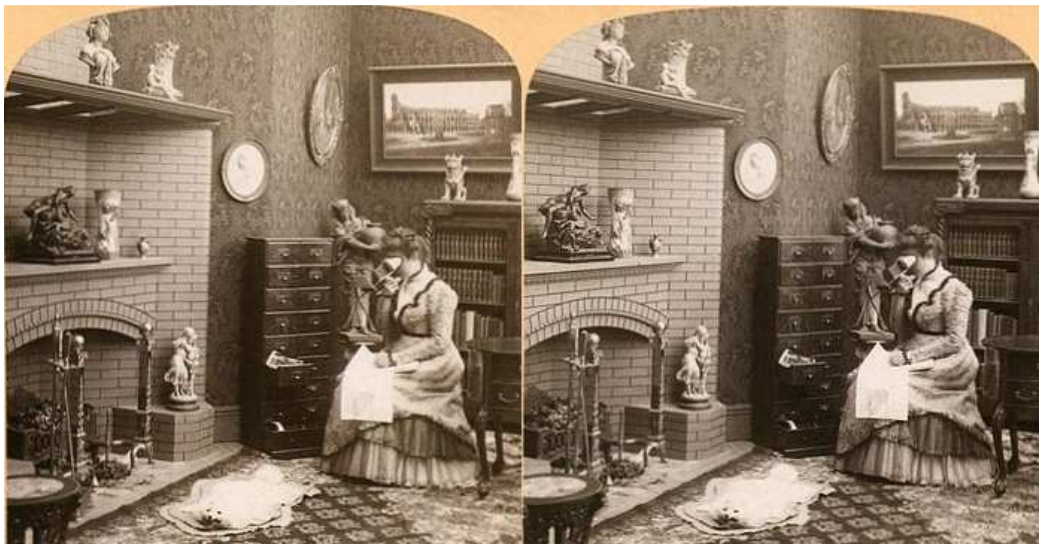
Humans see using a binocular vision, with each eye seeing a slightly different image than the other. Our brain interprets that visual information and makes it useful to us by combining the two images into one in a process called Stereopsis (Ray, 2005). This process involves visual information traveling from the eye, through the optic nerve and on into an area of the brain called the thalamus. It is here that the image gets processed and sent to the temporal lobes where the brain extracts motion cues as well as other visual cues that we then perceive as depth (Montgomery, 2008).



(Optometrists network, 2003)

The process of Stereopsis allows humans to perceive depth from two eyes.

It is because of Stereopsis that the effect of 3D can be replicated with such ease. Our brains use our eyes to find clues to establish the relationship between objects we see in each eye. As a result, our brains can be fooled into thinking we see depth, when in fact we are only looking at two images. Each image however must be created for and viewed by only one eye at a time. Early photographers were able to take advantage of this by placing two lenses close together to take a pair of images at the same time (Simanek, nd).



(Underwood and Underwood, 1902)

An early example of stereo photography.

What is 3D television?

Basic concepts

As early as the late 1800's, stereo images were being created by photographers all over the world using stereo cameras like the cameras made by George Hare. These cameras had two lenses that were set apart at approximately the same distance as human eyes. Today's 3D film and video cameras, with their high tech lenses and precision alignment capabilities provide the viewers of digital 3d with the same stereo pair of images.

(ignomini, nd)

A stereo camera created by George Hare circa 1875.

In order to work effectively, modern 3d television viewing systems must be able to maintain the separation of left eye and right eye images. Over the years of development, two types of displays have been developed that have made their way into the 3D TV market. The first type is stereoscopic and requires the use of special glasses. 3D TV's sold today require the viewer to wear active shutter classes, whereas 3D, like the movies projected using the RealD 3D projection system use passive polarized glasses (Shankland, 2011). The second type of 3D TV display is called autostereoscopic; this does not require the use of any glasses in order to see the 3D effect.

Active shutter

(Sony, 2011)

Active LCD shutter glasses from Sony.

All but a few 3D TV's produced today make use of an active shutter glasses system. 3D TV's that use active shutter glasses alternate the images for the right and left eye in rapid succession for each frame of the video or animation being shown. Each pair of glasses contains two LCD panels, one covering each eye. These panels switch on and off, exposing each eye to the proper image on the screen and giving the wearer the sense of 3D.

One advantage of this system is that the image on the screen can make use of every pixel one the screen. This lets a person watching a 3D presentation on a 1080P HDTV watch in full HD quality. Unfortunately, active shutter LCD glasses have several drawbacks. First, the glasses are costly, averaging about $100 per pair (Amazon, 2011). Second, wearing them for a long period of time to watch a movie can cause headaches and eye strain (Steenhuysen, 2010). The biggest problem is that they must be in direct line of sight of the IR emitter on the television in order to work. If anything gets in the way of the signal from the TV to the glasses, they will not work, and the viewer will not see the 3D effect.

Passive polarization

(Future Cinema Equipment, 2011)

A generic set of Passive LCD glasses available for $16.

The 3D cinema experience is very different from the home 3D TV experience primarily because you are not require to wear bulky active LCD shutter glasses. Cinemas and now a select few 3D TV's allow the viewer to wear lightweight and low cost passive polarized glasses to see the 3D effect. Passive 3D TV's make use of a polarized filter that blocks certain pixels for the left eye and alternate pixels for the right eye. This makes them easier to watch for long periods of time, however, it does reduce the overall image by one half (Strickland, 2011).

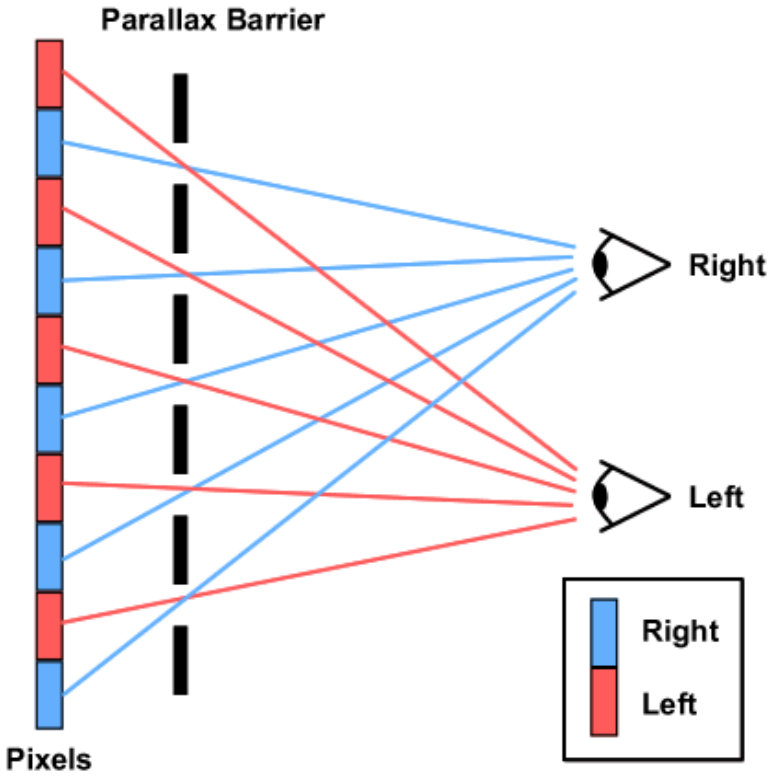
RealD and Samsung are two leaders in the field of 3D video that have recently announced the development of a new passive 3D TV technology called ZScreen to actively polarize the screen. This has the same effect as the active LCD shutter glasses, except it is part of the TV. This allows the use of passive polarized glasses while watching full HD quality 3D (Shankland, 2011).

Autostereoscopic displays

The second major category of 3D TV displays is called autostereoscopic, and does not require the viewer to wear any glasses in order to see the 3D effect. This provides autostereoscopic displays with several major advantages over the ones requiring glasses. First and fairly obvious is the 3D effect can be viewed by anyone looking at the TV, even as they pass by it. Second, and probably the most important is that the autostereoscopic displays can be viewed by a large number of people in an open setting. There is no need to have a supply of glasses available for people to put on near the display.

Autostereoscopic displays also come in two types, based on how the left and right eye images are separated for display. The first is type uses what is known as a parallax barrier to cause the viewers left and right eyes to see different pixels on the screen. The other uses a set of lenticular lenses place on the surface of the screen to accomplish the task of separating the left and right eye images.

Parallax barrier

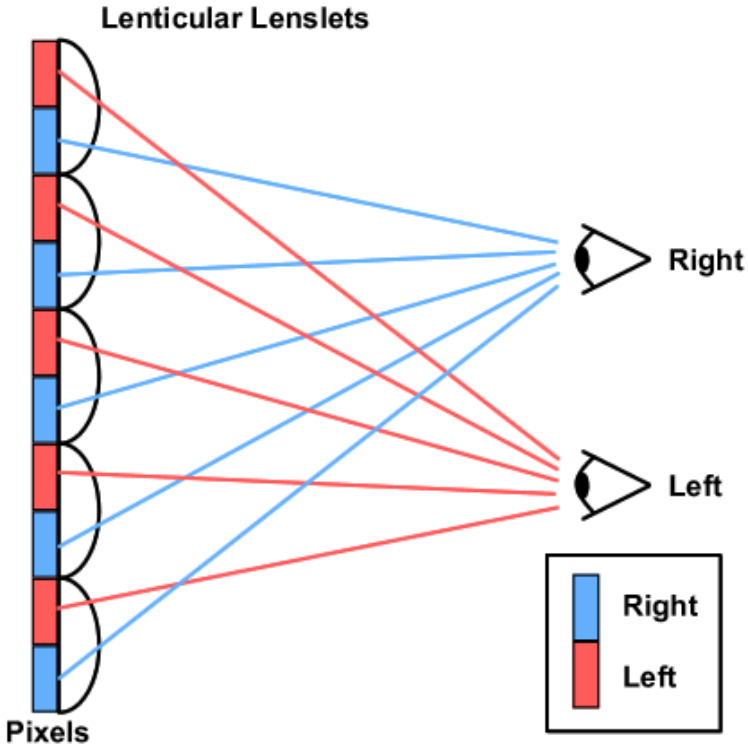


(3D Forums, nd)

The parallax barrier blocks the view of pixels for each eye.

Many autostereoscopic displays are based on the use of a parallax barrier type of screen to deliver the 3D effect to the viewer. Many of today's 3D TV's that use parallax barriers make use of an LCD panel place in front of the video screen. This arrangement give the viewer the ability to switch between a 2D viewing mode for watching regular video content and a 3D viewing mode for watching 3D content on the same television.

Lenticular lens



(3D Forums, nd)

The lenticular lenses cause each eye to see a different image.

The lenticular lens based 3D TV's use a series of cylindrical lenses placed directly on the surface of the screen to direct the light from two adjacent pixels to the left and the right eye. The lens causes the viewer to see the 3D effect without the need for glasses. Unlike the parallax barrier method, the monitor can only be used in 3D mode because the lenticular lens is permanently bonded to the screen.

Glasses free 3D TV

Who are the players?

Today's 3D TV marketplace is dominated by the primary television manufacturers like Sony, LG and Samsung. However, new companies have entered the market with their own take on 3D TV technology.

For the most part, the smaller companies have focused more on the autostereoscopic display market instead of the home entertainment market.

One of those companies is Alioscopy, based in San Diego, California. They have been a pioneer in the glasses free 3D TV marketplace for several years, getting a jump on the competition in both market exposure and content. However, they are not alone; recently, Toshiba, Samsung, LG and Fujitsu have all gotten into the glasses free 3D TV marketplace.

Content and delivery

While the manufacturers are all scrambling to be the best, content developers are just now beginning to catch up to the technology that is out in the market. The biggest problem that faces developers no is which market to be active in? Another issue; and one that is quickly being handled by both the manufacturers and content developers is how to get the 3D content to the screen.

On the broadcast side there are new formats that are using 2D plus Z (Depth) technique that relies on technology in the TV to reassemble the 3D image. (Fehn, 2001) Others are locating the computer or other device that is driving the display close enough to be directly connected to it.

Acceptance of 3D TV technology in the marketplace

Barriers to acceptance

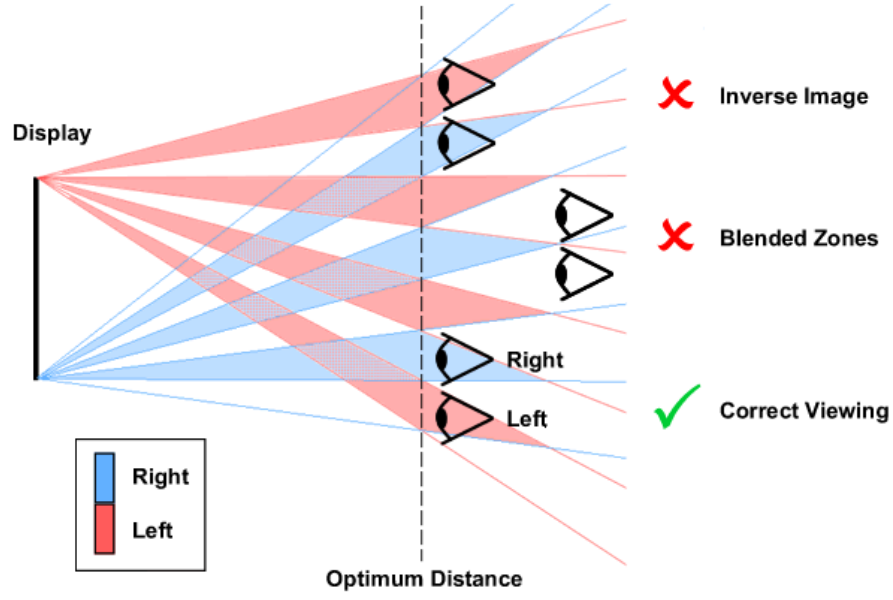
Some believe that 3D TV was introduced too soon, causing it to struggle in the marketplace and limit its acceptance.

> Some would say the TV manufacturers put the cart before the horse; they launched too early. A number of broadcast providers moved very quickly to try to pump 3D down a TV infrastructure and there's been a deafening quality backlash. The value of going to the trouble of get a 3D TV and

> putting on glasses means there has to be a payoff and the payoff can't be a headache. (David Cole, 2011)

3D TV manufacturers are having as they try to get consumers and corporations to adopt 3D as the future of television technology. Televisions that require the viewer to wear glasses are causing eye strain and headaches. This is a problem that the industry is addressing, how it will end up is anyone's guess at this point.

Autostereoscopic or glasses-free displays are not without their barriers to acceptance either. When viewing a parallax barrier or lenticular lens base 3D display, the viewer must locate themselves within "sweet spots" within the viewing area of the display. (3D Forums, 2009) This can be a big disadvantage for this technology in the home 3D TV market by causing people to have to sit in one spot for an entire presentation. As with the glasses required technology, these problems are being worked on and will change at the technology evolves.



(3D forums, nd)

Finding the correct viewing spot for an autostereoscopic display can be a problem for the technology.

Commercializing the technology

From the large screen to the small screen

To many, watching a 3D movie is an experience available only at the movie theater. Going to a cinema to watch a 3D movie can be a breathtaking experience. 3D TV manufacturers and content producers alike want that to change. While movies will always provide a larger than life 3d experience, lot's of industries are looking towards the small screen for a majority of 3D content. For example, the NFL showed its first game televised in 3D on September 2, 2010 between the New York Giants and the New England Patriots. (Bode, 2010) Signaling the beginning of what could be the biggest use of 3D TV, sports viewing.

Benefits of autosterescopic display technology

While the broadcast market is targeting the home 3D TV user, the autostereoscopic TV manufacturer is touting its strong points. For each of the technologies one major advantage is that the TV's can be used in public spaces where people are walking freely through the area. This allows many times more viewers to see the 3D content than can in the same situation with the TV's that require glasses.

(iPONT,nd)

iPont makes use of an autostereoscopic display in a public location.

Current autostereoscopic 3D TV Markets

Digital signage opens its arms

Glasses-free 3D technology has many uses in a broad range of industries. However, it is the digital signage industry that has looked at the technology and embraced it as the next generation of digital marketing and information display. Autostereoscopic displays are making their way into trade shows, car dealers, and shopping malls around the world. And companies are springing up to take advantage of this new and growing segment of the digital signage market.

The Future of autostereoscopic 3D TV

So where is the future of autostereoscopic 3D? One can only postulate where it will go in the next five years, considering the amount of progress in the past five years. What can be evaluated is where it can be used as an effective means of communicating ideas and entertaining audiences.

Future markets

As the future of 3D technology evolves, the markets that will embrace it will also evolve and open to the use of this new visual technology. Glasses-free 3D has profound implications for doctors and medical diagnosticians. 3D technology already allows them to visualize a CT scan on a computer monitor. With the incorporation of autostereoscopic viewing capabilities, it could open up completely new possibilities for the diagnosis of medical problems.

Future technologies

There are many companies working on a variety of new 3D technologies. They range from gimmicky displays that you can use with an iPad, such as Aircord's N-3D display system; (N-3D, 2011) to the

science fiction like project MIT's Media Lab is working on. The next generation of 3D television, may very well be holographic television. MIT is currently working holographic technology that can write and rewrite true 3D holographic images at a rate of 15 frames per second. While not the 30 frames required for true video, it is one technology that is a real possibility in the not too distant future. (Bourzac, 2010)


(MIT, 2011)

MIT Media Labs get closer to holographic television.

Conclusion

The glasses-free 3D television technology is now available to the masses. This evolution of television has the power to reshape whole industries and bring 3D visual experience to those people who have never experienced it before.

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