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The History of Stereoscopic Video Games for the Consumer Electronic Market

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Abstract

This paper focuses on at-home electronic gaming systems with true stereoscopic displays that were produced for the consumer electronic market and made available for retail purchase and aims to be the most accurate historical account to date. Systems which floor set in retailers and achieved some amount of consumer sell through will be organized chronologically by the date of their release, establishing an accurate timeline in which a historical account may be presented. The technical specifications, hardware designs, user interfaces and software releases will be summarized and determine which stereoscopic category each fall into based on the specific format the medium's content is presented in and device in which it is displayed.

Introduction

Stereoscopic gaming has remained a priority of video game developers throughout the history of electronic video games from its inception until this present moment, as virtual reality headsets now take center stage and push the parallel stereoscopic formats forward. Numerous attempts at capturing a consumer market base have been made throughout its history, utilizing the breadth of formats in which stereoscopic information can be communicated, and continue to make attempts to capture this lucrative market base. Unfortunately, the history of stereoscopic video games has yet to be accurately documented. Research was authenticated at The International Center for the History of Electronic Games at The Strong Museum of Play in Rochester N.Y., which houses the world's largest collection of video games and related ephemera.

As it currently stands, five stereoscopic electronic games were available for retail purchase in 1983 and jointly share the title of being the first stereoscopic video games ever produced for the consumer markets. The Tomytronic 3D handheld games, the 3D Gamate handheld, the Zaxxon Tabletop games, and more recently, the Vectrex Arcade System with 3D Imaging Headset. Although only the Vectrex Arcade System can truly be considered a video game as it being the only example with a true video display, common nomenclature regards the electronic games.

Handheld LCD Games with Stereoscopic Side by Side Graphics.

These games are handheld near eye displays designed in binocular styled housing with game controls at handholds and displayed stereoscopic paired graphics. They both LCD screens which needed external illumination to see gameplay. LDC panels darkened or allowed light to be transmitted through certain areas of gameplay creating a rudimentary animation of game sprites.

Tomytronic 3D Handheld Games, Tomy: 1983

Tomy released a total of 7 different game titles for the Tomytronic 3D line of stereoscopic electronic games in two patented styles of housing. Tomytronic 3D were part of the Tomytronic line of electronic games, and the first three of its titles appear in the 1983 Tomy trade catalog [1] and were made available for consumer purchase in American, European and Asian markets the same year [2] [3]. Each game was housed in its own specific colorway of binocular styled casing, controls were located at the top of the unit so the game could be played comfortably while held to the eyes (Fig 1). They simulated full color gameplay by overlaying a colored transparency over the game's LCD screen, which needed an external source of illumination. Separate left and right magnified viewports displayed the stereoscopic light left and right pair of game sprites on the LDC game field, programmed to illuminate simultaneously during gameplay [4]. A second generation of the game was designed with left and right speakers added for stereo sound [5]. 2 separate game titles were released for this new style one of which was licensed to Tandy and manufactured in a third colorway.

Fig 1. Tomytronic Video Game Line up

3D Gamate Handheld Console, V-Tech: 1983

V-Tech also produced a similarly styled stereoscopic handheld game, the 3D Gamate in 1983 for European Markets. They also featured binocular viewports with stereoscopic right and left views and an LCD display which needed external illumination, but it featured a variety of games on removable cartridges [6]. All of the games were actually programmed within the unit itself, each cartridge closed one electrical path, specifying which game program to play. The cartridges were simply transparent overlays with different game sprites that fit over the units' internal LCD screen, providing different graphics during gameplay (Fig 2), giving way to it being considered the first portable cartridge based stereoscopic gaming device [7].

Fig 2. V-Tech 3D Gamate Console and Removable Games

Volumetric, Reflection Based, Multiplane VFD Displays

Both games licensed Sega's 1982 arcade tile Zaxxon [8], one of the first polyphonic graphical games ever created; which is the oldest repeating title in stereoscopic video game history [9]. Both games also utilized reflection based designs similar to what is known as a "peppers ghost" display, where light is reflected off of the front surface of a transparent substrate and transmitted through the back simultaneously, creating two observable display planes (Fig 3).

Zaxxon, VFD Tabletop Game, Coleco: 1983

Coleco's tabletop version of Zaxxon retailed in American and European markets in 1983 [2] [3]. Coleco's tabletop housed a novel display system with 2 VFD displays and a half-silvered mirror, which was utilized to superimpose one reflected video display over a transmitted video display giving the lighted gameplay appearance of 2 planes [10].

FL Zaxxon Tabletop Game, Bandai: 1983

Bandai 's Japan only release of Zaxxon, also housed a peppers ghost display in a tabletop format, only uses 1 VFD display [11] which achieves the same effect. The VFD is bisected by the mirror, the upper half you see as the lower part of the playing field, while the lower part of the VFD is reflected on a semi-transparent mirror to create the upper half of the 3-D playing space, and is printed in reverse [12].

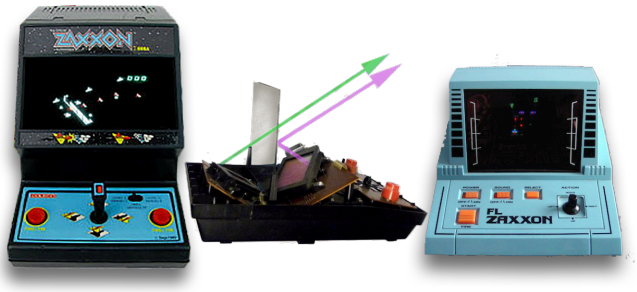

Fig 3. Coleco's and Bandai's Tabletop Games, With Cutaway of Coleco's Interior.

Active Sequencing Display Hardware, Alternating Field Displays

"Active" methods of stereoscopic viewing are reliant on persistence of vision, and actively filter stereoscopic left and right views of images in an independent manner respectively to the viewers left and right eye. Most modern sequencing techniques of alternating field display have roots dating back to the late 1800's utilizing time, color, and phase transmission sequencing [13]. The most famous and cited example the "time sequential" technique was patented in 1922 by Laurens Hammond, called the Teleview system, along with the release of the first stereoscopic 3D feature film [14]. This time sequential display used a light eclipsing shutter method for its active viewing system. A disk half opaque and half transparent spun at high speed with films projecting left and right views corresponding in time to the rate each eye's field of view was un-shuttered.

Mechanical Shutter Disk, Time Sequential and Color Sequential

3D Imaging Headset and 3D Games for the Vectrex Arcade System, GCE: 1983

The Vectrex arcade system is was a short-lived video game console built by Smith Engineering/GCE in 1982, bought out by Milton Bradley at the height of the North American Video Game Crash of 1983. It is a stand-alone system with a built in black and white CRT vector display that also housed a cartridge port, two control ports (one which was included and folded into the units' housing) and came preloaded with the game Minestorm. The 3d imaging headset was a peripheral released in 1983 [15, 16], along with a small library of proprietary 3D games, and is it the first stereoscopic peripheral for a video game console. The headset had utilized an optically controlled shutter disk which rotated at a speed that was twice the refresh rate of the CRT screen. One half is opaque black and blocks out light, the other half is transparent and divided into RGB color segments, which transmitted RBG colored light (Fig 4). This technology is similar to the shutter disk system found in the video arcade Subroc 3D, by Sega, the first commercially stereoscopic video game, released a year earlier in 1982 [17].

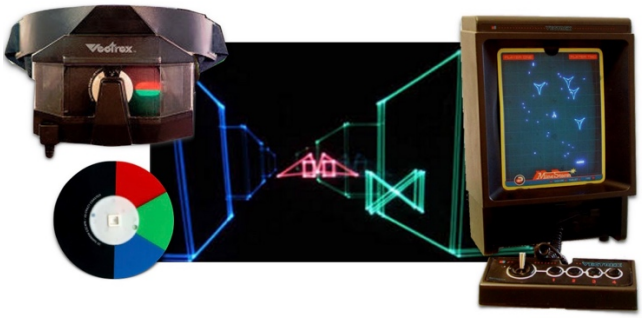

Fig 4.Vectrex 3D Imaging Headset, Color Wheel, Screenshot of 3D Narrow Escape and Vectrex Arcade System.

Active LC Shutter Glasses

Fig 5. Crystaleyes and Transmitter by Stereographics

Liquid crystal shutter glasses alternately blacken the left and right lenses through electrical current as left and right views of a games displayed graphics in an alternating field forma, kept in synchronization to the interlace refresh rate of the display by IR and RF transmitter. The technology dates back to 1968, to a flight simulator developed to help helicopter pilots to land at night, nicknamed "The Sword of Damocles'", It was invented by Ivan Sutherland and is not only the first example of active shutter glasses, it is also the first head mounted display and the first instance of "augmented reality", as the lenses were transparent, allowing the real world to be viewed with graphics superimposed on top [18]. Shutter glass technology that was further developed in early 80's by Stereographics, a company founded by Lenny Lipton who used an IR signal to sync the shutter glasses he developed, called Crystaleyes (Fig 5.), which were the first commercially viable 3D glasses product and developed 3D projection systems for movie theatres [19].

Famicom 3D System for Famicom, Nintendo: 1987

Nintendo released the Famicom on July 15 1983 a home video game console only available to the Japanese market. It was redesigned and sold as the NES to American markets in1985, Europe in 1986 and AU in 1987. In 1987, Nintendo's released proprietary active shutter glasses and an RF transmitter called the 3D System Scope and 3D System Adaptor, along with titles for stereoscopic gameplay. They were released only in Japan for Famicom consoles and are only compliant with PAL CRT monitors (Fig 6) [20].

The Sega 3D Glasses for Sega Master System, SEGA: 1987

Sega introduced the Mark III in 1985, a home video game console released only in Japan, which was redesigned for foreign markets and released as the Master System to North American markets in 1986, to Europe in 1987, and South American markets in 1989. The Sega 3D Glasses were one of many gaming peripherals released in 1987 along with a range of specially coded games for stereoscopic play and an RF adaptor to modulate the shutter rate of the Sega 3D Glasses (Fig 6) [21].

Stereotek 3-D Glasses, LC Technologies: 1987

Released through the Antic catalog in May of 1987 [22] for the Atari ST in the USA. They were developed by Tom Hudson and Gary Yost, the authors of Autodesk and 3D Max software [23] and had a small number of games available (Fig 6) [24].

Fig 6. The Shutter Glasses of 1987- The Sega 3D Glasses, Famicom 3D System and Stereotek 3-D Glasses.

Passive Viewing Methods

Anaglyph Formatted Games: 1987

It seems there were attempts being made to produce anaglyph games for home computers as early as 1981. The first advertised game that came packaged with red/blue anaglyph glasses was 3-Deep Space, which was available for BBC Micro, Commodore 64, VIC-20, and ZX Spectrum in 1983 [25]. Unfortunately, there is debate as to whether it actually produced three-dimensional graphics on any of the platforms [26].It wasn't until 1987, when Nintendo released anaglyph mode versions of 3-D World Runner and Rad Racer for the NES in the USA (Fig 7), that the format produced real stereoscopic gameplay and has since been adopted by many game manufacturers and platforms as a suitable stereoscopic format. Physical production of anaglyph glasses gradually changed from red/dk blue or red/dk green to the red/cyan we more commonly use today, to more easily match color the color frequency output on monitors [27].

Pulfrich Formatted Games: 1990

The Pulfrich effect is a psychophysical percept wherein lateral motion of an object in the field of view is interpreted by the visual cortex as having a depth component, due to a darkened lens (Fig 7) which causes a relative difference in signal timings between the two eyes [28]. Orb 3D was the first pulfrich game released for the NES in 1990, followed by Jim Power: The Lost Dimension in 3-D, released in 1993 for the SNES [29].

Fig 7. 3D Rad Racer with Anaglyph Glasses, Pulfrich Glasses.

Autostereogram Games for Freeviewing: 1994

An autostereogram is single image stereogram, and the first instance of this 3d illusion in a game released in 1994 for home computers called Magic Carpet. It had an autostereogram mode as well as anaglyph mode [30], as seen in this PC Zone review in 1994 (Fig 8).

Fig 8. PC Zone Review of Magic Carpet's 3D Modes.

Pioneer LaserActive, 3-D Goggles and PACS, Pioneer: 1993

The Laser Active system is worth mentioning as the only Laser Disc system with stereoscopic capabilities. It had expansion ports built in which allowed different modules to be ported in and expand the unit's capabilities. Expansion PACS were licensed from Nintendo and NEC and allowed their titles to be played on the system and it was also compatible with Sega and Nintendo's and active shutter glasses [31]. Four 3d ready titles were released on laser disc, which employed anaglyph, autostereogram, side by side and cross view pairs for free viewing, imagery for pulfrich glasses and active interlaced graphics for shutter glasses- the most variety of stereoscopic viewing options for a system or game title to date (Fig 9).

Fig 9. Pioneer LaserActive, Nintendo & NEC Extension PACS shown on top of the unit, Pioneer LaserActive Shutter Glasses, a tip-in sheet of perforated tear out Passive Glasses included with 3D Museum

Near Eye Displays

Near eye displays can be traced back to the stereoscopes of the 1800's which displayed static images. They can be held, worn, or positioned for a viewer to look through and use numerous methods and means to directly display stereoscopic imagery to a viewer's eyes. They have used two video inputs, inputting a time sequential or frame sequential multiplexing, or by multiplexing a single side by side or top-bottom formatted video stream into the respective left and right eye views.

Dual Oscillating SLA Displays

Virtual Boy Console, Nintendo: 1995

The Virtual Boy has a very unique near eye display, it was sold with a stand to use as a tabletop console and is the first actual "virtual" stereoscopic display for consumer purchase. It uses a pair of 1×224 linear arrays (one per eye) and rapidly scans the array across the eye's field of view using flat oscillating mirrors, vibrating back and forth at very high speeds, each pattern of LEDs is displayed for only 0.000052 seconds (Fig 10) [32]. The core display technology was licensed from Reflection Technologies [33].The technology console called Advent Industries [34].

Figure 10. Head Mounted Displays. Top left, i-glas bottom left, VFX-1, right, Sony PLM-50

Fig 10. Virtual Boy Console and Controller, Shown with Internal Components for SLA and Mirror Array

Head Mounted Displays: 1995

As stated earlier, Ivan Sutherlands "Sword of Damocles" is considered the first stereoscopic head mounted display, but it also employed an interactive tracking system to gauge the viewers position in relation to the virtual environment. In 1961 Philco created a head-mounted display single CRT element (making it monoscopic) with a magnetic tracking system, called the Headsight. Directional head tracking became more modernized and manageable

The first commercially available, stereoscopic head mounted displays with consumer-friendly price points ($1000 and under), arrived in 1995. The Forte VFX-1 retailed for $500 and had stereoscopic displays, 3-axis head-tracking, stereo headphones and a handheld controller called the Cyberpuck. I-O Display Systems

released the first of their i-glasses series that same year. Both had dual LCD displays capable of 180k = 263*230*3 and were available for PC use [35]. Another pioneer in this field was Sony, which released the PLM-50 Glasstron in 1996. It had as an optional accessory a positional sensor which permitted the user to view the surroundings, with the perspective moving as the head moved.

Software Driven Multiplexing

Many software developers have created driver, that support stereoscopic video games that use compatible hardware and active shutter 3D glasses. AMD HD3D, DDD TriDef, and NVidia 3DVision have been made available for PC gaming. For video game consoles, however, stereoscopic 3D support must be specifically built into each game. Potential stereoscopic game support is available, for instance, on Xbox 360, PlayStation 3, Xbox One, Wii U and PlayStation 4 [36].

NVidia Driver for PlayStation 2, 2001

When used with compatible hardware, the NVidia 3d stereo driver allows full screen stereo viewing of many open direct 3d or open based games. When 3d games are played and the driver is enabled, the driver will process the scene and render 2 or more images each frame for a 3D effect. It displays stereoscopic gameplay in anaglyph format or through page flipping, and works on windows operating systems from 95 to 2000 and XP. NVidia continues to support stereoscopic gaming on pcs and consoles.

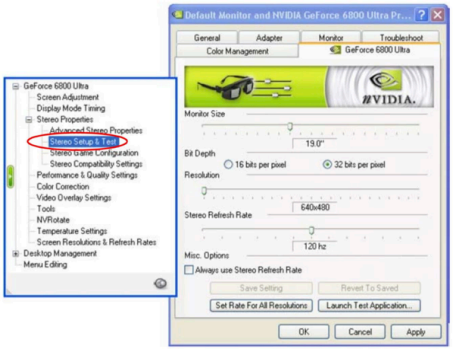

Fig 11, Screen shot for stereoscopic settings on screen

Modern Optical Stereoscopes

Much like the stereoscopes at the turn of the century, our modern-day stereoscopes are designed to view a stereoscopic pair of images and we use our smartphone in the same manner as we would a stereocard, and two lenses direct your eyes to converge on image pairs on the display.

Solid Eye/Tobidacid add-on for use with the Metal Gear Acid, for Sony PlayStation Portable- 2006

The only stereoscopic game designed for the PlayStation Portable was Metal Gear Acid. It was rendered in a side by side parallel format and packaged with pop up cardboard stereoscope called the Tobidacid solideye, which slipped over the PSP's screen and allowed stereoscopic viewing.

Smart Phone Viewers and Headsets

Ten million Google Cardboard smartphone viewers have shipped since they debuted in 2014, and they are the most widely distributed smartphone headset ever manufactured [37]. Although they lack the features that most of the more advanced, consumer targeted headsets have, many games and apps are available for it, designed to be played with the few means of input the Google Cardboard offers.

Fig 12. Cardboard stereoscopes. The Tobidacid for PlayStation Portable and Google's Cardboard.

Autostereoscopic Displays

Autostereoscopic display technologies can include a lenticular lens array or a parallax barrier, they can also be volumetric, holographic or light field displays. Sega demonstrated an early glasses-free 3D display system, called the Floating Image System in 1997 but was never released. The two broad approaches currently used to accommodate motion parallax and wider viewing angles: eye-tracking, which limits the number of displayed views to just two and multiple views so that the display does not need to sense where the viewers' eyes are located [38].

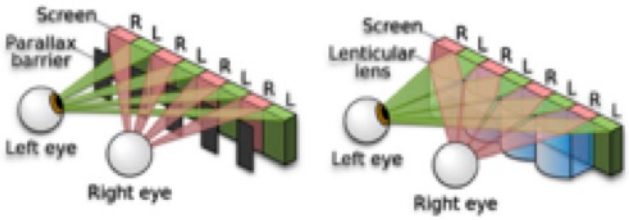

Fig 13. Illustrations detailing how the eyes receive information in a parallax barrier and a lenticular lens.

Nintendo 3DS & 3DSXL Line of Handheld Consoles, Nintendo: 2011

Nintendo released the first handheld video game with an autostereoscopic display, the Nintendo 3DS, in 2011, which was followed by a line of console up, the Nintendo 3DSXL in 2012, the New Nintendo 3DS in 2014 and the New Nintendo 3DSXL in 2015 (). The specs for The Nintendo 3DS's upper autostereo screen on the console: 3.53" autostereoscopic 3D LCD @ 800 × 240 px (400 × 240 WQVGA per eye). The specs for the 3DSXL's upper autostereo screen is 4.88" autostereoscopic 3D LCD @ 800 × 240 px (400 × 240 WQVGA per eye).

The entire Nintendo 3DS video game console family uses a parallax barrier for presenting 3D imagery, the New Nintendo 3DS line combines this with an eye tracking system. TN (twisted nematic) LCD displays are used for the autostereo screens, IPS (in plane switching) LCD screens on some of new releases [39].

Fig 14. The Nintendo 3DS and 3DSXL line of autostereoscopic gaming consoles.

Virtual Reality Display Systems

The term "Virtual Reality" is credited to Jaron Lanier, the founder of VPL Research. In 1984, they released the Eyephone, a stereoscopic head mounted display which was just one of many of the innovative and influential hardware and software virtual reality products manufactured by the company [40]. All of the current VR headsets marketed to consumers are stereoscopic head mounted displays with stereo sound and head motion tracking sensors and may use accelerometers, gyroscopes, structured light systems, or eye tracking sensors in their designs. They are also all bound to the same constraints in designing their headsets; latency issues, resolution and display quality and issues with lenses. At the moment, the major developers and drivers for consumer VR headsets are Oculus VR, PlayStation VR, the Samsung Gear VR and the HTC Vive [41].

Fig 15. Virtual Reality Headsets; Top Left, Oculus Rift. Bottom Left. PlayStation VR. Top Right, HTC Vive. Bottom Right, Samsung Gear VR.

End Thoughts

Stereoscopic communication has been a design priority of video game manufacturers almost since their inception. The technologies used reflect the technology of the day and the diversity and ingenuity in the types of displays manufactured throughout its history stress the importance of it to be made available to the general consumer.

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