Unleashing the Future of Display Technology: A Comprehensive Study on Screenless Displays and Their Types.

AJAY MANE[1] , Dr. Mrs. PRATIBHA ADKAR

MCA Department, PES Modern College of Engineering Pune, India

Abstract

A screenless display is a special kind of display that you can show or project wherever you want, like on a wall or in an empty area, without using an actual screen. With rapidly advancing technology in existing devices and tools, screenless display technology is poised to be a groundbreaking concept and a captivating area of research. This innovative technology addresses the challenge of limited display space in a single location by enabling the projection of information or data through electronic video sources without the use of screens. It represents the cutting-edge evolution of computer-enhanced technologies in the present era.

Keywords: Visual Image Display, Retinal Display, Synaptic Interface, Applications

1. Introduction

Screenless displays are a type of technology that is getting better and more advanced in the world of computer stuff. People think it's going to be one of the coolest things in the next few years. Numerous patents are still in progress to further develop this emerging technology, which has the potential to revolutionize the traditional concept of displays. The main goal of screenless displays is to share information without needing screens or projectors. This new trend of screenless displays is gaining popularity and becoming a prominent area of focus for the next generation. Screenless videos show ways to send visual information from a video source without using a screen. [2][4]

Fig.1 Screenless Display

Screenless display systems can be divided mainly into 3 groups:

- Visual image
- Retinal direct
- Synaptic interface

2. Types of Screenless Display

2.1 Visual Image

Visual Image screenless display means any kind of image that you can look at without a real screen. A hologram is a good example of this kind of display. [1]

Hologram

Holograms were primarily used in telecommunications instead of screens. You can

© 2023, IJSREM

send holograms directly or save them on storage devices like holodisks. If you want to see the stored hologram, you can connect the storage device to a holoprojector. Virtual reality goggles, even though they have two small screens, are also seen as screenless because they're not like regular computer screens. Heads-up displays in jet fighters also fall into the category of Visual Image displays as they project images onto the clear cockpit window. In all of these situations, light bounces off something like a hologram, LCD panel, or the window in a cockpit before it gets to your eye. With new software and hardware, users can customize and adjust the system to fit their individual needs, preferences, and capabilities. These advancements can allow the system to adjust to the user's behavior when interacting with movable type.[1]

Working of hologram

To make a hologram, you need a few things. First, there has to be something or someone that you want to record. Then, you shine a laser beam on both the object and a special material that has the stuff needed to make the image clear.

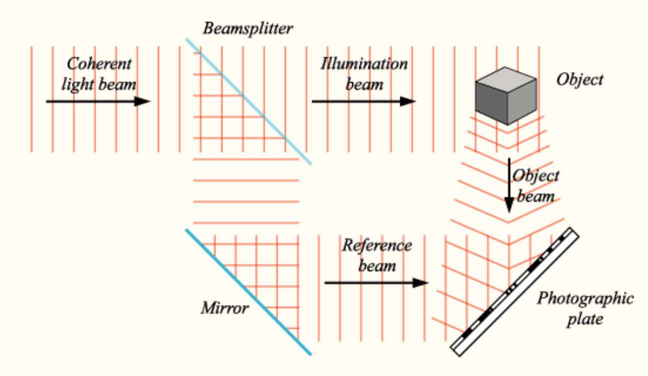

Fig.2 Recording a Hologram

To make sure everything works smoothly, the laser beam is divided into two identical beams using mirrors. One of the beams, called the object beam or illumination beam, goes towards the object. Some of the light bounces off the object and onto the special material for recording. The other beam, known as the reference beam, goes onto the recording material to make the image more accurate. The two beams meet and interact with each other, making a pattern of overlapping waves on the recording material. This pattern creates a virtual image that we can see with our eyes. It's really important to have a clear space so that the beams can meet and overlap correctly. [1]

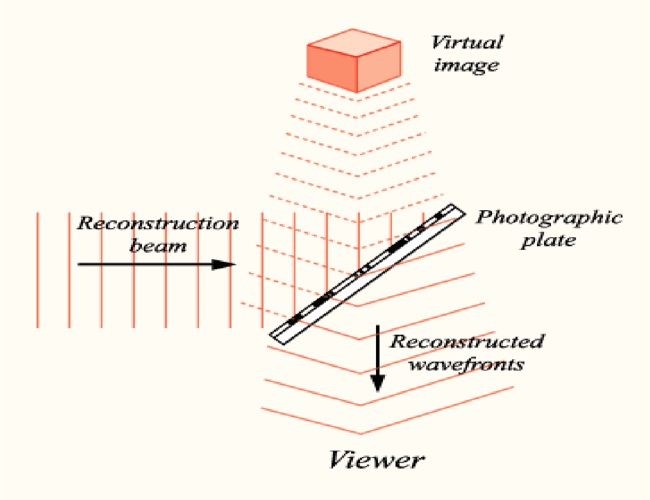

Fig.3 Reconstructing a Hologram

When you make a hologram, there are special parts inside it that help recreate the original object beam. This beam is exactly like the original one before it was combined with the reference wave. It's kind of like when a radio removes the wave that carried the information, and the wave goes back to its original state before it was sent out. The hologram beam also goes in the same direction as the original object beam, spreading out as it moves. Since the object was on the other side of the hologram, the beam travels towards you. When this light reaches your eyes, your eyes focus on it and your brain sees it as a 3D image behind the transparent hologram. It might sound strange, but it's like when you look in a mirror and see yourself and the things behind you. The light that makes this image bounces off the mirror's surface and goes into your eyes. Holograms also change the color of the object, so you see it as the same color as the laser used to make it, not its original color.[3]

In a hologram, the image you see is made from the light that bounces off the patterns created by the overlapping waves. This light spreads out as it travels to your eyes. However, the light that hits the opposite side of each pattern acts differently. Instead of spreading apart and going upward, it comes together and goes downward. This makes a clear copy of the object—a real image that you can see if you put a screen in its way. The real image is flipped horizontally and vertically, so it's the opposite of the image you see without a screen. With the right lighting, holograms can show both images at the same time.[4]

Your brain has a big role in how you see these images. When your eyes catch the light from the virtual image, your brain thinks it's light bouncing off a real object. It uses lots of clues like shadows, object positions, distances, and angles to understand what's going on. Your brain uses the same clues to make sense of the real image too, even though it's flipped around. [1][2]

2.2 Retinal Display

A virtual retinal display system is a type of screenless display that directly projects images onto the retina of the eye, as shown in Fig.4 Unlike visual image systems, which reflect light off of an intermediate object onto the retina, virtual retinal display systems project light directly onto the retina. These systems can give you a lot of privacy when you're using a computer in public because most people around you rely on seeing the same light that you see. But with retinal direct systems, the projected light only goes into the eyes of the person it's meant for. [2]

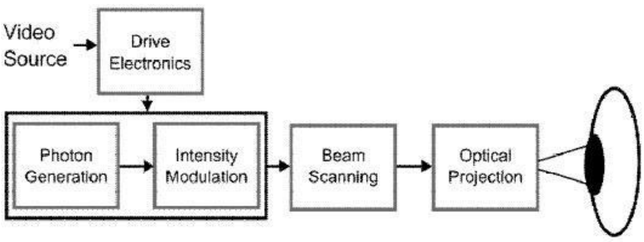

Fig.4 Block diagram of Retinal Display

To create an image with a VRD (Visual Retinal Display), a special light source called a photon source is used. It produces a beam of light that is coherent, meaning all the light waves are in sync. This synchronization helps the system create a very accurate spot on the retina. To show the image, the intensity of the light beam is adjusted to match the brightness of the displayed image. This adjustment can be made after the beam is generated. If the light source has a high bandwidth, meaning it can change its intensity quickly, like a laser diode, then the source itself can be directly adjusted to make the image appear. [1]

Once the image is modulated, it is then projected onto the retina by a scanner that moves the beam to the correct position for each pixel in the image. There are different ways that the scanner can work, such as a calligraphic mode that directly draws the lines of the image, or a raster mode that is similar to computer monitors and TVs. Our project mainly focuses on the raster mode of the VRD (Visual Retinal Display), which lets us use it with regular video sources. The raster is made by a scanner that moves the beam horizontally to draw a row of pixels, and then a different scanner moves it vertically to draw the next row of pixels.[2]

To see the image clearly, the VRD's optical beam needs to be projected correctly into the eye. The exit pupil of the VRD and the entrance pupil of the eye should be at the same level. When the eye looks at the light spot on the retina, it figures out where the image is located. The brightness of the spot is controlled by how the light beam's intensity changes. The light spot moves in a raster pattern, which helps create a steady and continuous image on the retina. Lastly, the

electronics that control the VRD synchronize the scanners and intensity modulator with the video signal. This ensures that the image stays stable and clear as it's displayed. [4]

Fig.5 Retinal Display

VRD STRUCTURE

A virtual retinal display (VRD) or retinal scan display (RSD) is a modern display technology that directly projects a raster display onto the retina of the eye. This means that users see a display that appears to be floating in front of them, much like a regular screen. Older versions of this technology projected a defocused image onto a small "screen" in front of the user's eyes, which had limitations such as a small screen area and high weight.[5]

Recent advancements have made it possible to develop a true VRD system that is bright enough to be used in daylight and can adapt to correct irregularities in the eye. This results in a high-resolution display without the need for a physical screen, offering excellent color range and brightness that surpasses even the best television technologies.[3]

The VRD was first invented in 1991 at the University of Washington and has primarily been used in conjunction with virtual reality systems. However, it can also serve as a display system for wearable computers, as well as portable devices like cell phones and media players. In these applications, the device is positioned in front of the user and employs facial scanning techniques to detect the eye.[5]

Looking ahead, mobile devices of the future will operate without touchscreens and physical screens. Instead, they will utilize laser-based displays that directly project images onto our retinas, alongside brain wave sensing implants. This integration of technology with our vision will create a more natural and intuitive user interface. We are on the brink of a hardware revolution that will make all of this possible, along with cloud-based information streaming that will facilitate this novel type of user interface. [1][4]

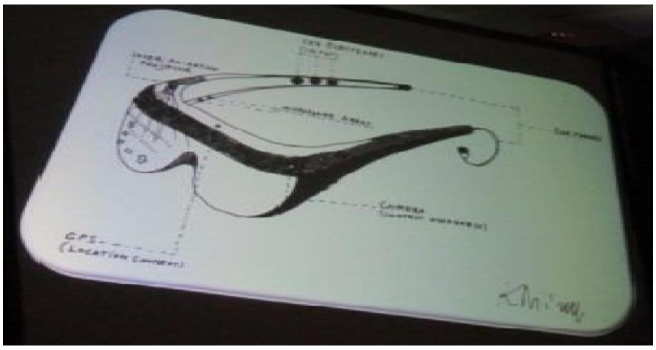

Fig. 6 Virtual Retinal Display –Example

2.3 Synaptic Interface

The Synaptic Interface screenless video technology works differently than traditional methods. Instead of using light to transmit visual information through the eyes, it takes a different route by directly sending the information to the brain. While this technology hasn't been tested on humans yet, researchers have been successful in extracting video signals from the eyes of live horseshoe crabs and transmitting video signals from electronic cameras into their brains using the same approach. [3]

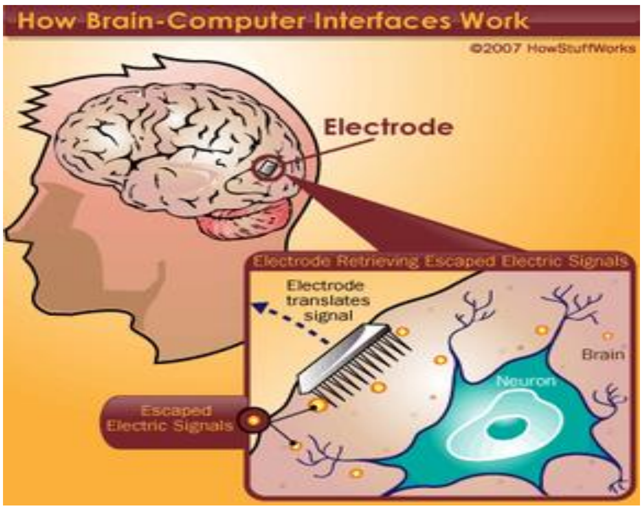

Fig. 7 Synaptic Interface

3. The Working Principle

Screenless displays are being developed using various technologies. One of them is the GEN-X wonder view, which combines different software programs. Any computer system capable of running Modoc software can display interactive text that can be moved around. In the upcoming years, Modoc software will mainly be used with personal computers, e-book readers, and other existing display and projection devices. A new type of input/output system called the tele-reader terminal is also on the horizon, which will enable communication and interaction between computers and users.

Another software product called Visual Image focuses on manipulating and composing bitmap images. These bitmaps can be individually adjusted in Image Mode or combined in Object Mode to create a "collage" of sorts. Visual Image has the ability to create and modify images of any size, although the limitations will depend on the available memory resources of your system. [3]

3.1 Creating Visual CatLog Files

Visual Image is a program that lets you make files in a special format called EYE. These files are useful for creating image catalogs with logical groupings of pictures. For example, you could create a catalog file that shows all pictures of different building materials such as brick, concrete, or stone.

To generate an EYE file in Visual Image, you can utilize the "File, Export Project" command. This action will create a new file that references all the currently opened images in Visual Image. During the process, you will be prompted to provide a name for the file you are creating. If there are any unsaved images in Visual Image, you will be asked if you want to include them in the EYE file. Choosing to include them will save them as bitmaps.

Moreover, Visual Image provides an "Export Editor" command, which allows you to selectively choose image files from your computer to be included in a catalog EYE file. By selecting "File, Export Editor" in Visual Image, a file browser will appear, enabling you to pick and add specific image files to your project file for use in Visual Catalog. [1]

3.2 Additional Software and Hardware Requirements.

- To enable or enhance the level of interaction.
- To improve the user's ability to perceive and understand information.
- To offer the user a visually healthy environment.
- Reacting to diverse user commands, which can be conveyed through voice, hand gestures, foot movements, or other signaling methods.
- Supplying indications or reactions through blinking.
- Making adjustments to the output to accommodate changes in the user's physical condition or response time, among other factors, is an important aspect. The improved software and hardware will enable both the user and the system to effectively utilize their respective strengths and work together as a fully integrated team. [1]

4. Applications

- **Automotive**: Car windshields can display navigation and speedometer information through heads-up displays (HUDs) without distracting the driver from the road.
- **Healthcare**: Medical professionals can use screenless displays to view patient information and vital signs during surgeries or procedures without looking away from the patient.

- **Manufacturing**: Workers can use smart glasses to access real-time production data, assembly instructions, safety guidelines without having to hold a device.
- **Education**: Teachers can use screenless displays to show virtual models and simulations to students during science, technology, engineering, and math (STEM) lessons.
- **Retail:** Customers can use augmented reality (AR) displays to see how products would look in their homes or on their bodies without having to physically try them on.
- **Gaming**: Players can use AR and virtual reality (VR) headsets to immerse themselves in interactive game environments without traditional screens.
- **Military**: Soldiers can use helmet-mounted displays to receive information and communicate with their team members without using their hands.
- **Sports**: Athletes can use AR displays to visualize plays and review their performances without interrupting training or practice.
- **Aviation**: Pilots can use HUDs to view flight data and navigation information without taking their eyes off the controls.
- **Construction**: Architects and builders can use AR displays to visualize and design structures before they are built, making it easier to detect potential issues before construction begins.
- **Entertainment**: Movie theaters can use AR and VR displays to create immersive viewing experiences for audiences.
- **Museums**: Visitors can use AR displays to see additional information about exhibits or to view virtual reconstructions of historical sites.
- **Advertising**: Marketers can use AR displays to create interactive advertisements that engage customers and promote brand awareness.
- **Hospitality**: Hotels and restaurants can use AR displays to provide customers with information about their services, amenities, and menus.

5. Advantages

Portability

Screenless displays can be much smaller and more lightweight than traditional displays, making them easier to transport and use in different environments.

Hands-free operation

Screenless displays can be operated using voice commands, gestures, or other types of input that don't require the user to touch or hold a device, making them ideal for situations where hands-free operation is necessary, such as while driving.

Immersive experiences

Because screenless displays can project images and information directly onto the user's environment, they can provide a more immersive experience than traditional displays, especially for virtual and augmented reality applications.

Enhanced accessibility

Screenless displays can be designed to provide information in alternative ways, such as through vibrations or sounds, making them more accessible for people with visual impairments or other disabilities.

Enhanced safety

Screenless displays eliminate the need for users to stare at screens for extended periods, which can cause eye strain, headaches, and other health issues. They also reduce the risk of accidents caused by distracted driving or walking while using a device.

Better accessibility:

Screenless displays can be used by people with visual impairments or those who cannot see screens due to medical reasons. The technology can display information directly onto the user's retina, allowing them to perceive images without the need for a physical screen.

6. Challenges

Potential health risks

Some screenless display technologies, such as holographic displays, may emit harmful radiation that could pose health risks to users.

Eye Strain and Fatigue

Because screenless displays project light directly onto the retina, they can cause eye strain and fatigue, especially if used for extended periods of time. This can lead to headaches, dry eyes, and other vision problems.

Lack of visual cues:

Screenless displays rely on other sensory cues, such as audio or haptic feedback, to convey information. However, these cues may not be as intuitive or as easy to understand as visual cues, which can make it challenging for users to interpret information.

Learning curve:

Using screenless displays may require users to learn new ways of interacting with technology, which can be challenging and time-consuming. It may also require additional training or support for users to fully understand how to use these devices.

Cost:

Screenless displays can be more expensive than traditional screens, especially if they use cutting-edge technologies like holographic displays.

Motion sickness:

Screenless displays that rely on virtual or augmented reality technology can cause motion sickness, particularly if the user is prone to motion sickness or the display is not calibrated properly.

Contextual limitations:

Screenless displays may struggle to display information in certain contexts, such as in bright sunlight or in low light conditions. This can make it difficult to use the device in certain environments or situations.

7. Future Enhancement

Transparent and flexible display technologies may become more advanced, allowing for unique screenless display applications. For example, transparent displays could be integrated into windows, eyewear, or other surfaces, providing information or visual content without obstructing the view. Flexible displays could be rolled, folded, or stretched, offering new possibilities for screenless display design.

Virtual reality (VR) and augmented reality (AR) technologies are expected to advance further, offering more immersive and interactive experiences without the need for traditional screens. In the future, we might see the integration of VR and AR directly into our surroundings, allowing us to interact with digital content seamlessly.

Brain Computer Interface may allow us to visualize information and images directly in our minds, eliminating the need for physical screens altogether. This could enable a new level of information sharing and communication.

Holographic displays are likely to become more advanced and widespread. These displays create three-dimensional images that appear to float in mid-air without the need for any physical screen. Future enhancements may include increased brightness, sharper images, and improved color reproduction, making holographic displays more realistic and visually appealing.

8. Conclusion

Screenless display technology is a captivating and fast-evolving field that holds the promise of transforming our interaction with digital content in groundbreaking ways. The development of new techniques, such as Synaptic Interface and GEN-X wonder view, are paving the way for new input/output systems that will make communication and interaction with computers more intuitive and seamless. Additionally, software programs like Visual Image are allowing us to create and manipulate images in new and innovative ways, such as creating EYE files for cataloging and logical sub-groupings. As this technology continues to develop, we can look forward to a future where screenless displays are the norm and digital content is more accessible and integrated into our everyday lives.

9. REFERENCES

[1] K. Ranganath, M.Sravanthy, P.Krupali "SCREENLESS DISPLAYS – THE EMERGING COMPUTER TECHNOLOGY" in journal of " International Journal of Engineering Research and Application." published in Vol. 1, Issue 3, pp.942-947 .

[2] Parimal S. Bhosale, Kulkarni Niraj Rajeev, Kurkute Shubham Sanjay, " Screen less Display", in journal of **"**International Journal of Scientific Research in Computer Science, Engineering and Information Technology**"** published in January-February-2022.

[3] LAVANYA.K, Dr.N.SHANMUGAPRIYA2 "SCREENLESS DISPLAY", in journal of "International Journal of Engineering Technology, Management and Applied Sciences" published in Vol 10,Issue 9, Sept /2019 ISSN NO:0377-9254.

[4] A. Vikas, "Screenless Display Technology", in journal of "International Journal of Engineering and Computer Science" published in Volume 7 Issue 6 June 2018, Page No. 23997-24002 ISSN:2319-7242.

[5] https://chat.openai.com/c/7a13739f-230d-49bc-923f-8342987bcbdc