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Screenless Display Technology

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Abstract:
Technological advancement nowadays is moving to a faster pace. The latest display technology -Touch Screen Display, commonly used in our smart phones and tablet computers will move to a mere history in the coming future. Lack of space is one of major problem faced by screen displays. This emerging new display technology will replace this touch screen environment and will solve the problems at higher level, making life more comfortable. The main aim of the Screenless Display is to display or transmit the information without the help of a screen or the projector. Using this display, we can directly project images onto the human retina, open space and even to the human brain. It avoids the need of high weight hardware and it will provide privacy at a high rate. This field came into progress during the year 2013 by the arrival of products like holographic videos, virtual reality headsets, retinal displays, mobiles for elderly, eye tap etc. At present, we can say that only part of the Screenless Display Technology is brought up which means that more advancement is necessary for a boost in the technology. This problem will surely provide a pathway for screenless display.
Keywords-privacy, transmit information, directly project images.

1. Introduction

Screenless, as the word suggests clearly means 'no screen'. So, Screenless Displays can be defined as a display which helps to display and even transmit any information without the aid of screen. Screenless Display was an excellent thought that came into many experts in order to solve the major problems related to the device miniaturization. Lower space screen displays have made the need of screenless displays more than ever. Screenless displays are capable of projecting 3D images to the space, many disadvantages of 2D and screen based displays can be avoided. Displaying feature of it can be thought of as a projector without a movie. Using this excellent technology, we can even make our smart phone a TV. The countdown for the first screenless display has started now currently from the month of May 2014 onwards. Screenless Display currently uses Interactive Projection technology with visual display and 3D Projection Technology.

Figure 1.1 Screenless display

2. Types of Screenless Display

Screenless display technology is divided into three main categories:

1) Visual Image Display
2) Retinal Display
3) Synaptic Interface

2.1 Visual Image Display:

The visual image is a type of screenless display, which recognizes any type of image or thing with the help of the human eye. The following are few examples of the visual image display: holographic display, virtual reality goggles, heads up display, etc. The working principle of this display states that the light gets reflected by the intermediate object before reaching the retina or the eye. The intermediate object can be a hologram, Liquid Crystal Displays (LCD)s or even windows.

By using the components like Helium Neon Laser, an object, a Lens, a holographic film and mirror, the Holographic Displays display the three-dimensional (3D) images. A 3D image will be projected and appears to be floating in the air whenever the laser and object beams overlaps with each other. This display can supply accurate depth cues and high-quality images and videos that can be viewed by the human eyes without any need of special observation devices. Based on the colors of the laser projector, images are formed in three distinct planes. Holographic displays are commonly used as an alternative to screens.

Figure 2.1.1 Holographic display

Heads up display are also named as transparent displays. These displays are applied in different applications such as aeroplanes, computer games and automobiles, etc. Many of the users do not need to look away from their field of view because the device displays the information on a windshield. An ordinary heads up display comprises of following components: a projector unit, combiner and a computer. The projector unit projects the image, and the combiner redirects the displayed image by that projected image, and the field of view are seen simultaneously. The screenless computer acts as an interface between the projector and the combiner (data to be displayed).

Figure 2.1.2 Heads up Display

The main advantage of visual image displays is creating and manipulating the images up to any size. In this category of displays, multiple bitmaps can be composited together in the object mode and, in the image mode, manipulation takes place. In this display system, Eye files are created which consists of all the images that are loaded. The EYE file creates a ‘Export Project Command’ in the file. These commands in EYE file provide a provision to save any sort of unsaved images in the form of bitmaps into it. A common catalog is created to place the browsed images from ‘Export Editor Command’ in the ‘EYE’ file.

2.2 Retinal Display:

The second category of advancement in display system, retinal display as the name itself indicates the display of image directly onto the retina. Instead of using some intermediate object for light reflection to project the images, this display directly projects the image onto the retina. The user will sense that the display is moving freely in the space. Retinal display is commonly known as retinal scan display and retinal projector. This display allows short light emission, coherent light and narrow band color. Let us know about this display with the help of the following block diagram.

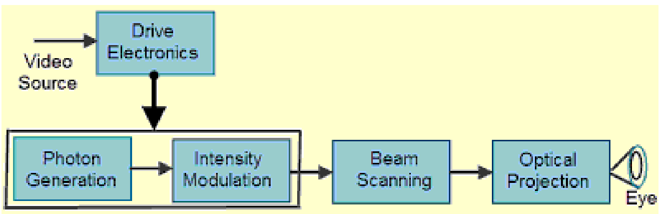

Figure 2.2.1 Block Diagram of Retinal Display

The block diagram of the virtual retinal display consists of following blocks: photon generation, intensity modulation, beam scanning, optical projection and drive electronics. Photon generation block generates the coherent beam of light; this photon source makes use of the laser diodes as coherent source with retina display to give a diffraction onto the retina of the human eye. The light generated from photon source is intensity modulated. The intensity of the light beam gets modulated to match the intensity of the image.

Figure 2.2.2 Example of retinal display (google glass)

The modulated beam gets scanned by the beam scanning. By using this scanning block, the image is placed onto the retina. In this beam scanner, two types of scanning modes take place: raster mode and vector mode. After the scanning process, optical projection takes place for projecting a spot-like beam onto the retina of the eye. The spot focused on the eye is sketched as an image. A drive electronics placed on the photon generator and intensity modulator is used for synchronization of the scanner, modulator and coming video signal. These displays are made available in the market by using MEMS technology.

2.3 Synaptic Interface:

The third category, synaptic interface means sending information directly to the human brain without using any light. This technology is already tested on humans and most of the companies started using this technology for effective communication, education, business and security system. This technology was successfully developed by sampling the video signals from horse crab eyes through their nerves, and the other video signals are sampled from the electronic cameras into the brains of creatures.

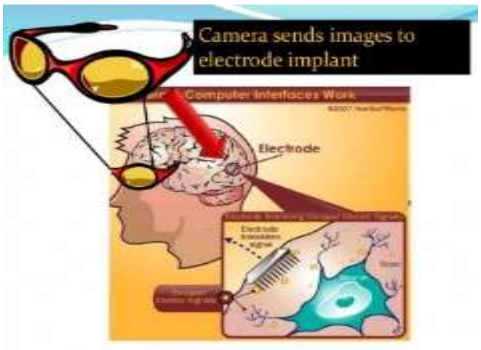

Figure 2.3.1 Synaptic Interface

The synaptic interface allows direct interaction between the human brain and external devices such as computer. This category can also be known by different names such as human machine interface, synthetic telepathy interface, brain computer interface, mind machine interface and direct neural interface. Below, let’s see how brain computer interface works.

3. Working of Brain Computer Interface

To get a higher-resolution signal, scientists can implant electrodes directly into the gray matter of the brain itself, or on the surface of the brain, beneath the skull. This allows for much more direct reception of electric signals and allows electrode placement in the specific area of the brain where the appropriate signals are generated. However, this approach has many problems. Since, it requires invasive surgery to implant the electrodes, and devices left in the brain long-term tend to cause the formation of scar tissue in the gray matter. This scar tissue ultimately blocks signals.

In the case of a sensory input brain computer interface (BCI), the function happens in reverse. A computer converts a signal, such as one from a video camera, into the voltages necessary to trigger neurons. The signals are sent to an implant in the proper area of the brain, and if everything works correctly, the neurons fire and the subject receives a visual image corresponding to what the camera sees. Another way to measure brain activity is with a Magnetic Resonance Image (MRI). An MRI machine is a massive, complicated device. It produces very high-resolution images of brain activity, but it can't be used as part of a permanent or semipermanent BCI. Researchers use it to get benchmarks for certain brain functions or to map where in the brain electrodes should be placed to measure a specific function.

4. Types of Brain Computer Interface

4.1 Invasive Brain Computer Interface:

Invasive brain computer interface research has targeted repairing damaged sight and providing new functionality for people with paralysis. Invasive BCIs are implanted directly into the grey matter of the brain during neurosurgery. Because they lie in the grey matter, invasive devices produce the highest quality signals of BCI devices but are prone to scar-tissue build-up, causing the signal to become weaker, or even non-existent, as the body reacts to a foreign object in the brain. BCIs focusing on motor neuroprosthetics aim to either restore movement in individuals with paralysis or provide devices to assist them, such as interfaces with computers or robot arms.

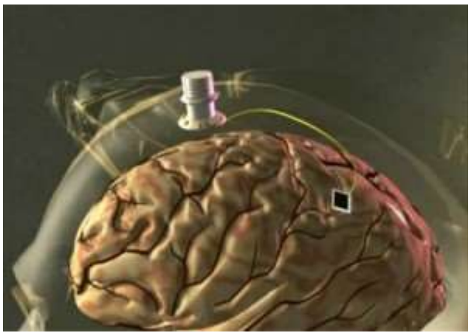

Figure 4.1 Invasive Brain Computer Interface

Tetraplegic Matt Nagle became the first person to control an artificial hand using a BCI in 2005 as part of the first nine-month human trial of Cyberkinetics's Brain Gate chip-implant. Implanted in Nagle's right precentral gyrus (area of the motor cortex for arm movement), the 96-electrode Brain Gate implant allowed Nagle to control a robotic arm by thinking about moving his hand as well as a computer cursor, lights and TV.

4.2 Partially Invasive Brain Computer Interface:

Partially invasive brain computer interface devices are implanted inside the skull but rest outside the brain rather than within the grey matter. They produce better resolution signals than non-invasive BCIs where the bone tissue of the cranium deflects and deforms signals and have a lower risk of forming scar-tissue in the brain than fully invasive BCIs.

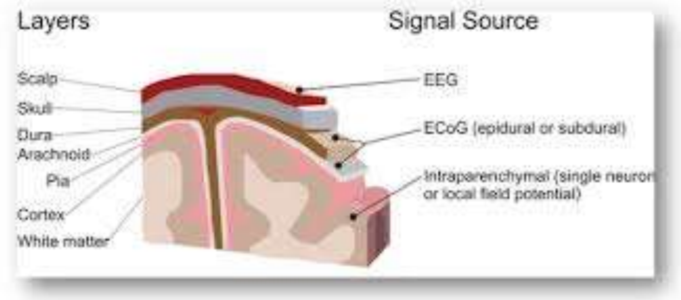

Figure 4.2 Partially Invasive Brain Computer Interface

Electrocorticography (ECoG) measures the electrical activity of the brain taken from beneath the skull, but the electrodes are embedded in a thin plastic pad that is placed above the cortex, beneath the dura mater. Signals can be either subdural or epidural, but are not taken from within the brain parenchyma itself. It has not been studied extensively until recently due to the limited access of subjects. ECoG is a very promising intermediate BCI modality because it has higher spatial resolution, better signal-to-noise ratio, wider frequency range, and less training requirements than scalp-recorded electroencephalography (EEG), and at the same time has lower technical difficulty, lower clinical risk, and probably superior long-term stability than intracortical single-neuron recording. This feature profile and recent evidence of the high level of control with minimal training requirements shows potential for real world application for people with motor disabilities.

4.3 Non-Invasive Brain Computer Interface:

Non-invasive brain computer interface does not involve neurosurgery. They are just like wearable virtual reality devices. The substantial majority of published BCI work involves noninvasive Electroencephalography -based BCIs. Noninvasive Electroencephalography -based technologies and interfaces have been used for a much broader variety of applications. Electroencephalography (EEG) is the most studied non-invasive interface, mainly due to its fine temporal resolution, ease of use, portability and low set-up cost. The technology is somewhat susceptible to noise however. EEG measures voltage fluctuations resulting from ionic currents within the neurons of the brain. In clinical contexts, EEG refers to the recording of the brain's spontaneous electrical activity over a period, as recorded from multiple electrodes placed on the scalp. EEG generally provides the recording through the electrodes placed on the scalp with a conductive gel or paste. Number of electrodes used by the current EEG BCI is within a range of few to 100 electrodes. Since electrode gel can dry out and the setting up procedure has to be repeated before each session of BCI use, EEG-based BCI are not convenient. As a possible solution, dry electrode arrays can be used.

Figure 4.3 Non-Invasive Brain Computer Interface

5. Advantages

Screenless Display has several key advantages:

1) Screenless – No fixed screen or display panel required, allowing content to be displayed on virtually any surface.
2) Portable – No fixed installation required, enabling Screenless Display product to be easily moved or taken on the go. In contrast, traditional big screen televisions are large and not easily moved or transported.
3) Scalable – The display image size scales with distance from the display surface, enabling images ranging from as small as few inches in diagonal to as large as 100 inches or more in diagonal from the same portable device.
4) Quick Set Up – No fixed installation or mounting on the wall or placement on a pedestal required allowing Screenless Display product to just power on and create stunning display.
5) Improved Aesthetics – No fixed screen required, allowing display to be only visible when required and invisible when turned off. Once the display is off, the room aesthetics are kept in its natural state without compromise – so there is no display panel to view "all of the time".
6) Small Size – No large display panel required, allowing Screenless Display product to be small size can be designed to fit in your pocket or carry in your hand.
7) Smart – Built-in video streaming applications and Wi-Fi, enabling Screenless Display product to provide all functionalities of a smart display.

6. Disadvantages

1) The principle disadvantage is that virtual retinal display (VRD) is not yet available in the significant numbers.
2) The limitation of conventional 3D displays is that the observer has no freedom of head movement or the freedom to increase information about the 3D objects being projected
3) Prototypes and special experimental models are now being built, but their cost per unit is high.
4) They may harm to eyes as these displays required closer interaction.

7. **Market Analysis**

1) The world screenless display market is segmented into type of technology, application, vertical and geography. Based on type, the market is segmented into visual image, retinal display and synaptic interface. Low power consumption, wider viewing angles and enhanced privacy associated with the technology are some of the factors driving the growth of the world screenless display market. Screenless displays do not occupy a huge amount of space unlike the screen-based displays, which is the key factor that would foster their adoption in future.
2) Visual image screenless display market is expected to dominate revenue over the forecast period, which can primarily be attributed to high demand for hologram technology.
3) North America screenless display market is expected to remain the industry leader, primarily due to presence of key participants. Manufacturers are constantly developing and enhancing the technology to make it more

sophisticated and to integrate it with consumer-grade devices. Google and Vuzix have aimed to increase adoption of smart wearable technology among consumers.

4) The global screenless display market is projected to reach USD 3416.15 million by the end of 2021, at a CAGR of 30.34% over the five-year forecasted period. Consumer electronics held the largest market share (44.12%) in the screenless display market globally owing to the increasing penetration of the mobile phones with larger display along with the increasing usage in the screenless laptops when connected to fixed screen monitors.

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