Holographic Image Display

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Overview

Background

- Holography is the science of producing holograms; it is a form of photography that allows an image to be recorded in three dimensions.The technique of holography can also be used to optically store, retrieve, and process information.
- Holography was developed by D. Gabor in 1947. He recognized that when a suitable coherent reference wave is present simultaneously with the light scattered from a 3D object, then information about the amplitude and phase of the scattered waves can be recorded, in spite of the fact that recording media responds only to light intensity. He demonstrated that, from such a recorded interference pattern, which he called a hologram, meaning a total recording, an image of the original 3D object can ultimately be obtained.
- However, recording a hologram of a real object requires some wave interference between two laser beams with a high degree of coherence between them in a dark room. Therefore, this system must be kept very stable since even a very slight movement can destroy the interference fringes, in which both intensity and phase information of the 3D object are contained. These requirements, together with the development and printing processes, have prevented conventional holography from becoming widely employed in the field. As a solution for these limitations of conventional holography, a computer-generated hologram (CGH) has been suggested.
- Compared to conventional holographic approaches, CGH does not rely on the availability of specialized holographic recording materials and it can synthesize optical wavefronts without having to record a physical manifestation of them, and offers unprecedented wavefront control by making it easy to store, manipulate, transmit, and replicate holographic data. Although CGH-based display systems can be built today, their high cost makes them impractical for many applications. However, as the computer and optical hardware costs decrease, CGH displays will become a viable alternative in the near future.

Source

Different Types of 3D displays

- **Stereoscopic display** creates the illusion of 3-D when displayed. Human visual system (HVS) sees a flat plane of pixels.
- **Volumetric displays** can create a 3-D computer graphics image, but fail to provide many visual depth cues (e.g., shading, texture gradients) and cannot provide the powerful depth cue of overlap (occlusion).
- **Discrete parallax displays** (such as lenticular displays) promise to create 3-D images with all of the depth cues, but are limited by achievable resolution.
- **Real-time electronic holographic (?holovideo?) display** can create a truly 3-D computer graphics image with all of the depth cues (motion parallax, ocular accommodation, occlusion, etc.) and resolution sufficient to provide extreme realism. Holovideo displays promise to enhance numerous applications in the creation and manipulation of information, including telepresence, education, medical imaging, interactive design, and scientific visualization.
- **Electro holographic display** generates a 3-D holographic image from a 3- D description of a scene. This process involves many steps, grouped into two main processes:

1. Computer graphics: Using camera a sequence of images is generated.
2. Fringe computation: 3-D description scene is converted into a holographic fringe using interference or diffraction approach.
3. Optical modulation: Optical, in which light is modulated by the fringe using SLM and optical lens.

- The technology of electronic interactive three-dimensional holographic displays is in its first decade.
- CGH provides flexible control of light, making it suitable for a wide range of display types, including 2D, stereoscopic, auto-stereoscopic, volumetric, and true 3D imaging. CGH-based display technology can produce systems with unique characteristics impossible to achieve with conventional approaches.
- Holographic 3D display is one of the attractive approaches for creating the most authentic illusion for observing volumetric 3D objects. It is because holographic technology can supply high-quality images and accurate depth cues viewed by human eyes without any special observation devices.

Existing Technologies in 3D Display Space:

Technology	Functionality	Disadvantages
Stereoscopic display systems	Using a stereo input image pair to display 3D images.	1. Images to be observed by left and right eyes are separately projected onto eyes 2.Viewer is required to wear special glasses such as anaglyphs, polarized or shutter glasses for separated reception of the left and right images on the eyes. 3. Only an observer can see a display target object three-dimensionally 4.Causes distortion in the

		scale of an image with changes in viewing distance. 5.Binocular parallax produces eye strain ie binocular parallax and the focus adjustment cannot be realized exactly 6.Causes Eye fatigue and Dizziness
Auto-stereoscopic three-dimensional display technology-	Optical elements such as lenticular sheets or parallax barriers are attached to display panels and they collect the left and right images displayed on the panel. Use a series of fine vertical bars or lenses to direct the two images correctly to each eye.	1.Causes Eye fatigue and Dizziness 2.Lenticular sheets or parallax barriers are attached to display panels and they collect the left and right images displayed on the panel
Conventional Holography OR Conventional optical elements	Recording a hologram of a real object using some wave interference between two laser beams with a high degree of coherence between them in a dark room.	1. System must be kept very stable since even a very slight movement can destroy the interference fringes, in which both intensity and phase information of the 3D object are contained. 2. Device will be heavy and will have alignment and packaging issues.
Real-time holography	Used for displaying holographic images in real time	1.Substantial communication bandwidth 2.Producing a different image for right and left eye
Computer-generated hologram (CGH)	Digital hologram generated by computing the interference pattern produced by the object and the reference waves. Computer generated holography (e.g., using computer generated holograms) can be used to convert 3D information to 2D for sending and receiving using existing communication networks.	1. High cost makes them impractical for many applications. 2.Packaging and alignment issues 3.Difficult to be implemented in smaller displays

3D Holographic display considerations:

- Large bandwidth
- High transmission rate
- Design considerations like alignment and packaging issues

- ♦ Holographic bandwidth compression and faster digital hardware enable computation at interactive rates and promise to continue to increase the speed and complexity of displayed holovideo images.

- ♦ Alignment and packaging of the optical lens and spatial light modulator is a big issue which can be removed using Infosys MHOE Technology.

MHOE Technology

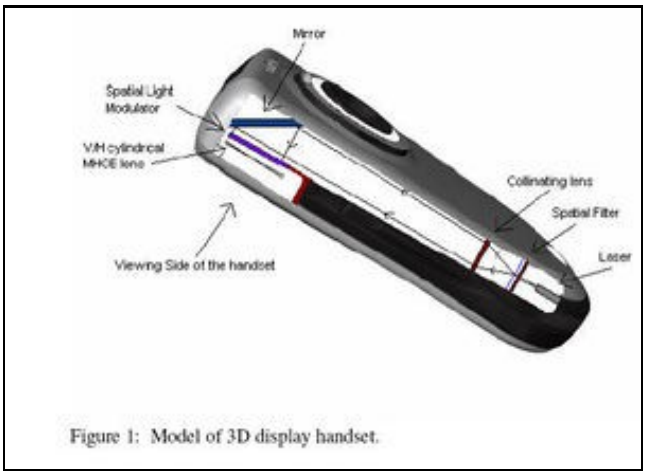


Figure 1: Model of 3D display handset.

Prototype-MHOE

- Micro holographic optical elements (MHOEs) are used for displaying a holographic three dimensional image of an object (e.g., received by the device in the form of a computer generated hologram via a communication network).

- The device for displaying holographic three dimensional images of objects includes a laser source, a spatial filter using a micro holographic optical element (MHOE) lens, a collimating MHOE lens, a spatial light modulator, and cylindrical MHOE lenses.
- The process of displaying holographic three dimensional image of an object using MHOEs include: emitting a coherent light, filtering and expanding the light, aligning the expanded light, modulating the aligned expanded light, and focusing the modulated light.
- HOEs require smaller and efficient elements of desired characteristics and transfer functions.
- Micro Holographic Optical Elements (MHOEs) can either be an HOE, recorded with two narrow beams of laser light or a segment cut from a larger HOE (SHOEs), and recorded in the conventional manner.

IP Validation

SNo	Search string-(1836-Till date)
1	**Full Text:** ((holographic*2 ADJ three ADJ dimensional ADJ image) AND display) AND (holographic*2 ADJ optical ADJ element)
2	**Full Text:** ((holographic*2 ADJ three ADJ dimensional ADJ image) AND display)
3	**Full Text:** (laser ADJ source) AND (spatial ADJ filter) AND (collimator) AND (optical ADJ lens) AND (HOE OR MHOE OR (micro ADJ holographic ADJ optical ADJ element) OR (holographic ADJ optical ADJ element)) AND (Spatial ADJ light ADJ modulator)
4	**Full Text:** (HOE OR MHOE OR (micro ADJ holographic ADJ optical ADJ element)) OR (holographic ADJ optical ADJ element)) AND (Spatial ADJ light ADJ modulator)
5	**Title, Abstract and Claims:** ((((Three OR 3) AND dimensional) OR (3 adj D)) AND (hologram OR holographic) AND image AND display) AND (HOE OR (holographic ADJ optical ADJ element))
6	**Title and Abstract:** ((((Three OR 3) AND dimensional) OR (3 adj D)) AND (hologram OR holographic) AND image AND display)

Patent Analysis

Executive summary

- This technology is not suited for consumer applications.
- This technology is most suited for industrial applications.

Novelty:

- Based on the Patents analyzed, no technique is available currently which allows the display of actual 3D in mobile. So, the overall set up is novel for the intended application of mobile/wireless device.

Technological advantages:

- Computer generated holograms, can be created, sent, received, and displayed using the technology.
- Multiple function capability and wavelength selectivity.
- Design flexibility and ease of replication- No alignment and packaging issues
- Rigid and stress resistant setup
- Transfer functions of multiple elements such as lenses, mirrors, gratings, etc. can be incorporated in a single MHOE
- Wave front corrections
- Desired splitting/coupling ratios can be achieved
- Computational power is less compared to other conventional technologies.

Limitations

- This MHOE HDS display is useful to display only text objects and image objects. It cannot be used for multimedia like video etc.Refer Claim4 and Claim5
- This MHOE HDS display needs a special screen for image rendering. Hence, any mobile that wishes to show both 2D and 3D images will have to install 2 distinctive screens for rendering 2D and 3D images respectively.
- This MHOE HDS cannot display computer converted 2D to 3D images.
- This MHOE HDS cannot be used for high end 3D graphics like gaming.

Reference

Applications

- Based on the above limitations, Dolcera believes the current technology is not suitable for consumer settings.
- Owing to its above limitations, Dolcera believes the current technology may have limited use in industrial applications market like warehouse applications.
- The current technology may be suited to both PDA and smart phone applications limited to the industrial applications market.

Market Valuation:

Market Predictions