Holography: A Review

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Abstract—**Holography is an optical imaging method that started to develop intensively in the half of the 60s in the last century. It was developed as a sort of photography that takes 3-dimensional images on a film by laser light reflected from the object and incident on the film. After the film is developed it is illuminated and the observer can see a 3-D image looking as if it were floating in the space. At present, holography belongs to interesting technologies and is used for studying processes and events in different disciplines, in practice and also to prepare art works and protect objects against counterfeiting, in the present communication we are discussing various aspect of holography which can lead to understand the various phenomenon related to holography.**

Index Terms—**Holography, Recording and Reconstruction of Hologram, Application of Laser, Research in holograms, Future application of holograms.**

I. Introduction

The word "holography" is originated from Greek word "holes" meaning the holes and "graphy" meaning the writing, i.e. holography means "complete recording" is a new method of recording the optical image in 3-D.The principle of holography was laid down by Galior and attained practical importance due to laser in 1960. In the year 1962, Lieth and Upatneiks introduced the techniques of off-axis holography which removed the difficulty associated with the in-line technique. Laser holography were first time prepared by Lieth and Upatneiks.

In an ordinary photograph we can see 2-D image of an object. For this we make use we make use of lenses to focus the image on the photo graphic plate. Thus, it is a 2-D recording of any 3-D object. [1] But in holography the light wave reflected from the object are recorded. That holographic record is called hologram. When hologram is illuminted with the coherent source of light it make a 3-D image of the original object. So holography is a two step process:

a) Transformation of object into hologram.

b) Reconstruction of hologram into image of the object.

II. Properties of Holograms

(1) The light is coming from hologram to eye is physically similar to light coming to eye looking at the original scene.

(2) The standard 3-D hologram are not in natural colour, but monochromatic at the colour of the reconstructed wave.

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(3) When a hologram is cut to pieces, and a piece is used for reconstruction, the whole seen is still seen.

(4) The feeling of 3-D vision through a hologram is not psychological effect, as in stereographic picture, but is a real.

(5) The maximum depth of field that can be seen in a hologram is the function of the coherence length of the laser.The maximum brightness and details that can be seen on the hologram are function of laser.

III. Laser in Holography

A. Basic Principle of Holography

➢ Gabor Hologram

The principle of holography was first put forward by Dennis Gabor. It was two step lensless imaging process. The first part was photographically recording of an interference pattern. The pattern was generated by the interaction of scattered quasi-monochromatic light (laser) from an object and coherent reference wave. He called the pattern is hologram. [4]

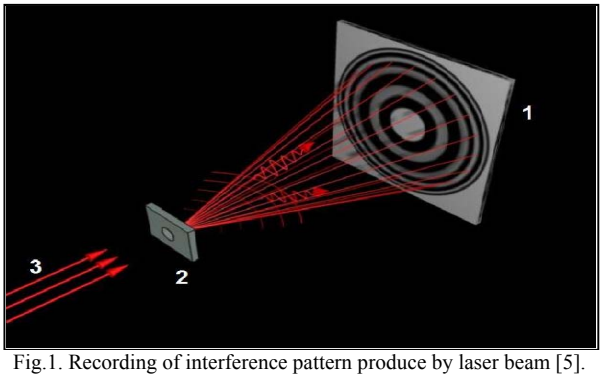

Fig.1. Recording of interference pattern produce by laser beam [5].

When a beam of coherent light scattered from an object is allowed to overlap on a unobstructed coherent beam, interference fringes are produced on a photographic plate placed infront of object. The scattered wave fronts are spherical with center at the point object. And scattered wavefronts are characterized by there amplitudes and phases. The scattered or diffracted light from the object is superimpose over the coherent incident light and produces a hologram on the photographic plate.

In the case of solid 3-D object, the object may be considered as collection of number of points. Each point diffracts its own set of complex spherical wave pattern. The interference pattern is formed on the photographic plate.

IV. Recording of A Hologram

First of all the laser beams are divided in two parts- one part illuminates the object and diffracted beam falls on photographic plate. Other beam is reflected on photographic plate by means of plane mirror. Thus, we obtain a complex interference pattern on film. The film is called hologram. [3]

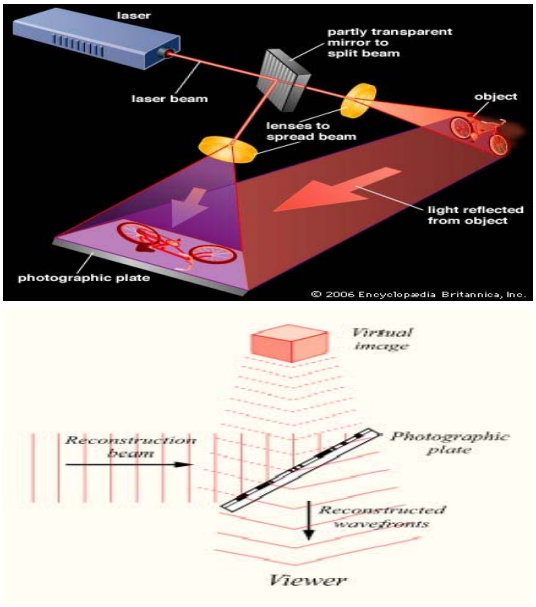

Fig. 2. Recording of hologram.

V. Reconstruction Of Image From Hologram

Reconstruction is reverse process of making a hologram. The hologram is illuminated by a single of laser. Here diffracted beam forms real image while another forms virtual image.by moving position of our eyes we can see different prospective of object in the image. [1]

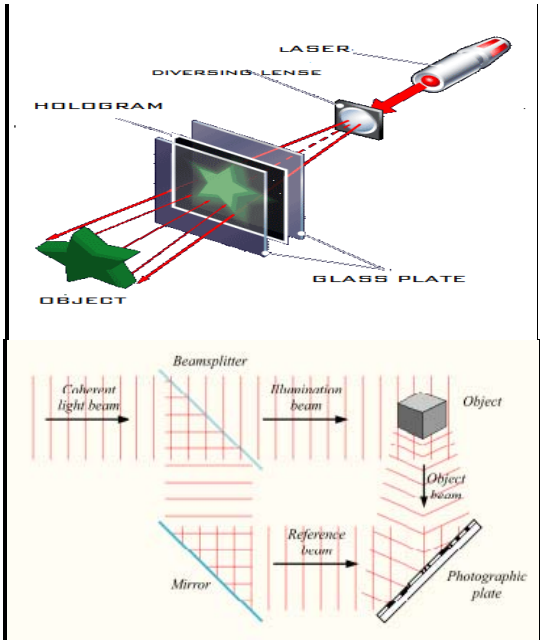

Fig. 3. Reconstruction using monochromatic line.

VI. Application of Holography

Holography is a very useful tool in many areas, such as in commerce, scientific research, medicine, and industry.

A. Current Applications that Use Holography Are

- Holographic interferometry is used by researchers & industry designers to test & design many things, tires and engines to prosthetic limbs and artificial bones and joints.
- Supermarket and department store scanners use a holographic lens system that directs laser light onto the bar codes of the merchandise.
- Holographic optical elements (HOE's) are used for navigation by airplane pilots. A holographic image of the cockpit instruments appears to float in front of the windshield. The pilot keeps his eyes on the runway or the sky while reading the instruments.

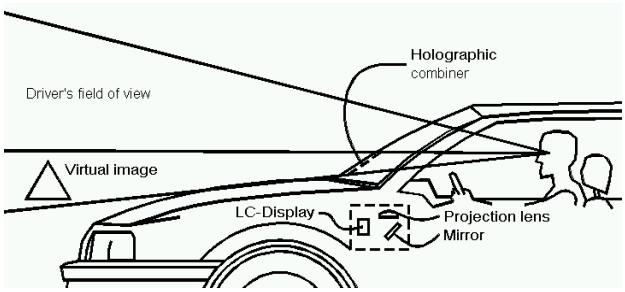

Fig. 4. Producing an image of cockpit instrument using hologram.

- Medical doctors can use three-dimensional holographic CAT scans to make measurements without invasive surgery. This technique is used in medical education.
- The use of holograms on credit cards and debit cards provide added security.
- Holography is used to for archival recordings of valuable & fragile museum artifacts.
- Sony Electronics uses holographic technology in their digital cameras to focus accurately in dark conditions. A holographic crystal allows the camera to detect the edge of the subject and differentiate between it and the background.

B. Future Applications of Holography Include

Future colour liquid crystal displays (LCD's) will be brighter and whiter as a result of holographic technology.

Scientists at Polaroid Corp. have developed a holographic reflector that will reflect ambient light to produce a whiter background.Holographic night vision goggles.[12]

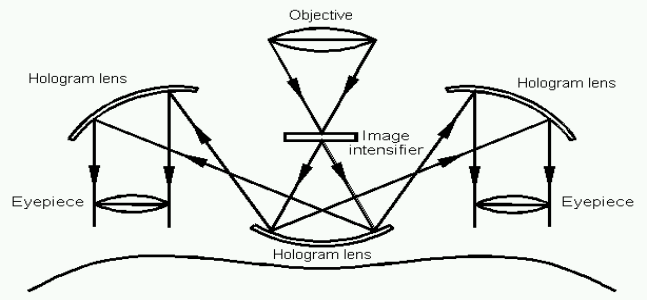

Fig. 5. Holographic night vision goggles.

- Many researchers believe that holographic televisions will become available within 10 years at a cost of approximately $5000. Holographic motion picture technology has been previously attempted and was successful in the 1970s. The future of holographic motion pictures may become a reality within the next few years.
- Holographic memory is a new optical storage method that can store 1 terabyte (= 1000 GB) of data in a crystal approximately the size of a sugar cube. In comparison, current methods of storage include CD's that hold 650 to 700 MB, DVD's that store 4.7 GB, and computer hard drives that hold up to 120 GB.

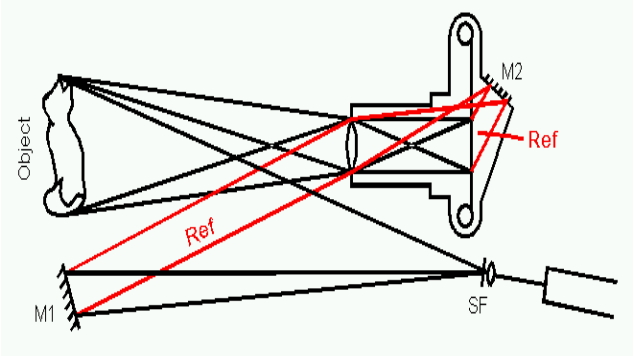

Fig. 6. Holographic motion picture technology.

VII. Holography vs Photography

A hologram differs from a photograph in several ways:

The hologram allows the recorded scene to be viewed from a wide range of angles whereas the photograph gives only a single view.

The reproduced range of a hologram adds many of the same depth perception cues that were present in the original scene, which are again recognized by the human brain and translated into the same perception of a three-dimensional image as when the original scene might have been viewed.

The photograph is a flat two-dimensional representation.The developed hologram surface itself consists of a very fine, seemingly random pattern, which appears to bear no relationship to the scene which it has recorded.

A photograph can be viewed in a wide range of lighting conditions, whereas holograms can only be viewed with very specific forms of illumination.

VIII. Conclusion

Holography is one of the best technology man has ever came up with. Holography is new technique which allows us to do the recording and playback of true, three-dimensional images which are called a hologram. Holography was invented by Dr. Dennis Gabor at the Imperial College of London. This happened in year of 1971. Dr. Gabor received the Nobel Prize in physics for holography.

Large-scale holograms, illuminated with lasers or displayed in a darkened room with carefully directed lighting, are incredible. They're two-dimensional surfaces that show absolutely precise, 3-D images of real objects. You don't even have to wear special glasses or look through a View-Master to see the images in 3-D.

Holography helps test materials such as auto engines, creates 3-D pictures for consumer packaging, improves airplane navigation and reduces the size of digital data storage.

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