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State of art about a hologram and distance learning

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ABSTRACT
In the future, hologram technology might support the learning process as it produces a three-dimensional (3D) picture. The 360° holographic display produces holographic images that can be viewed from any angle. A hologram will possess all the visual depth cues as if it were a real object. The actual size of models helps students to learn. Students are motivated by realistic reproductions.
This paper tries to shed some more light on the original hologram technique that had developed gradually and rapidly to reach the main object in life, "education". this part made more attention to the varieties in education media and tried to close the distance between the world.
Distance learning has provided an excellent platform for students in geographically remote locations while enabling them to learn at their own pace and convenience. Many technologies are currently being utilized to conceptualize, design, enhance and foster distance learning. Teleconferences, electronic field trips, podcasts, webinars, video conferencing and online courses are among such technologies used in providing distance learning opportunities. However, limitations in those existing technologies have affected the increase of distance learners' dropout rates. As an attempt to overcome the limitations in the currently adopted distance learning practices, the study aims to utilize 3D Hologram Technology (3DHT) to facilitate live and life-size 3D telepresence that can interact with remote audiences.
Keywords: 3D hologram, in-line hologram, off-axis hologram, Fourier plane hologram

I.INTRODUCTION

Holography dates from 1947 when British/Hungarian scientist Dennis Gabor developed the theory of holography while working to improve the resolution of an electron microscope. Gabor, who characterized his work as "an experiment in serendipity," coined the term hologram from the Greek words holos, meaning whole, and gramma, meaning message. Further development in the field was stymied during the next decade because light sources available at the time were not truly coherent (monochromatic or one-color, from a single point, and of a single wavelength)[1].

Gabor, Denisyuk, Leith, and Upatnieks developed distinct optical geometries for holography, but all of them rely on a two-step process. First, two beams from a single coherent source of light (usually a laser) are combined to yield interference fringes. One of those beams (known as the reference beam) strikes the photosensitive surface directly. The other (the object beam) is reflected onto the surface, or otherwise modulated, by the object to be imaged. The combination of the two beams yields a fine pattern of interference fringes. This is a series of dark lines at positions where the two beams differ in phase by a half-wavelength of light and bright lines where the difference amounts to a whole wavelength. The average scale of this pattern (known in communication theory as the carrier frequency) is related to the angle between the reference and object beams. In Leith-Upatnieks holograms, the angle is typically between 10 and 100 degrees; in Denisyuk holograms, the angle is about 180 degrees and the reference beam strikes the photosensitive plate from the side opposite the object beam. Because the optical set-up must remain motionless to a fraction of a fringe during exposure, this means that the Denisyuk technique demands even more scrupulous vibration isolation than does the Leith-Upatnieks method. That yields different types of holograms dah been developed to reach today's advanced 3D hologram models.

II.HOLOGRAM CHARACTERISTICS AND TYPES

The development of the hologram technique, followed by the invention of the laser, which provided a powerful source of coherent light, resulted in a surge of activity in holography that led to several important applications.

The in-line hologram

We consider the optical system shown in fig. 1 in which the object (transparency containing small opaque details on a clear background) is illuminated by a collimated beam of monochromatic light along an axis normal to the photographic plate.

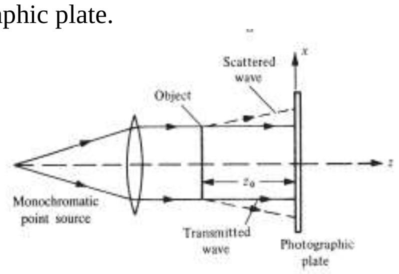

Fig. 1. An optical system is used to record an in-line hologram.

The light incident on the photographic plate then contains two components. The first is the directly transmitted wave, which is a plane wave whose amplitude and phase do not vary across the photographic plate. Its complex amplitude can, therefore, be written as a real constant r. The second is a weak scattered wave whose complex amplitude at any point (x, y) on the photographic plate can be written as o(x, y), where $|o(x, y)| \ll r$.

Since the resultant complex amplitude is the sum of these two complex amplitudes, the intensity at this point is

$I(x, y)=|r+o(x, y)|^2,$

$I(x, y)=r^2+|o(x, y)|^2+ro(x, y)+ro^*(x, y),$ (1)

where $o^*(x, y)$ is the complex conjugate of o(x, y). 'positive' transparency (the hologram) is then made by contact printing from this recording. If we assume that this transparency is processed so that its amplitude transmittance (the ratio of the transmitted amplitude to that incident on it) can be written as:

$$t=t_0+\beta TI,$$ (2)

where t_0 is a constant background transmittance, T is the exposure time and β is a parameter determined by the photographic material used and the processing conditions.

Finally, the hologram is illuminated, as shown in fig. 2, with the same collimated beam of monochromatic light used to make the original recording.

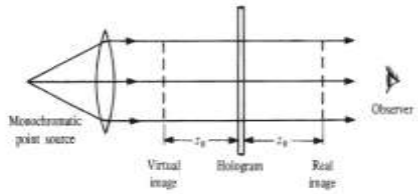

Fig. 2, Optical system used to reconstruct the image with an in-line hologram, showing the formation of the twin images.

Since the complex amplitude at any point in this beam is, apart from a constant factor, the same as that in the original reference beam, the complex amplitude transmitted by the hologram can be written as:

$u(x, y)=rt(x, y)$
$=r(t_0+\beta Tr^2)+\beta Tr|o(x, y)|^2 +\beta Tr^2o(x, y)+\beta Tr^2o^*(x, y).$ (3)

The right-hand side of (3) contains four terms. The first of these, $r(t_0+\beta Tr^2)$, which represents a uniformly attenuated plane wave, corresponds to the directly transmitted beam. The second term, $\beta Tr\,|o(x, y)|^2$, is extremely small, compared to the other terms, and can be neglected. The third term,$\beta Tr^2o(x, y)$, is, except for a constant factor, identical to the complex amplitude of the scattered wave from the object and reconstructs an image of the object in its original position.

The fourth term, $\beta Tr^2o^*(x, y)$, represents a wave similar to the object wave, but with the opposite curvature. This wave converges to form a real image (the conjugate image) at the same distance in front of the hologram.

With an in-line hologram, an observer viewing one image sees it superimposed on the out-of-focus twin image as well as a strong coherent background.

Another drawback is that the object must have a high average transmittance for the second term on the right-hand side of (3) to be negligible. As a result, it is possible to form images of fine opaque lines on a transparent background, but not vice versa. Finally, the hologram must be 'positive' transparency. If the initial recording is used directly, β in (2) is negative, and the reconstructed image resembles a photographic negative of the object[2].

Off-axis holograms

To understand the formation of an image by an off-axis hologram, we consider the recording arrangement shown in fig. 3 in which (for simplicity) the reference beam is a collimated beam of uniform intensity, derived from the same source as that used to illuminate the object.

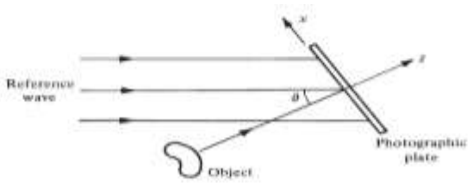

Fig. 3 The off-axis hologram: recording.

The complex amplitude at any point (x, y) on the photographic plate due to the reference beam can then be written as:

$r(x, y)=r \exp(i2\pi\xi x)$, (1)

where $\xi=(\sin\theta)/\lambda$, since only the phase of the reference beam varies across the photographic plate, while that due to the object beam, for which both the amplitude and phase vary, can be written as

$o(x, y)=|o(x, y)| \exp[-i\varphi(x, y)]$. (2)

The resultant intensity is, therefore,

$I(x, y)=|r(x, y)+o(x, y)|2$ (3)

The amplitude and phase of the object wave are encoded as amplitude and phase modulation, respectively, of a set of interference fringes equivalent to a carrier with a spatial frequency of ξ.

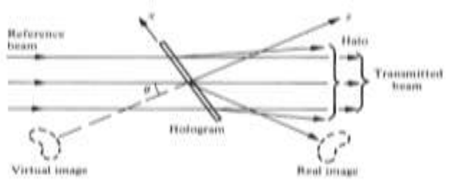

Fig. 4 The off-axis hologram: image reconstruction

Since the depth of the real image is inverted, it is called a pseudoscopic image, as opposed to the normal, or orthoscopic, virtual image. It should also be noted that the sign of β only affects the phase of the reconstructed image so that a 'positive' image is always obtained, even if the hologram recording is a photographic negative.

Fourier holograms

An interesting hologram recording configuration is one in which the complex amplitudes of the waves that interfere with the hologram are the Fourier transforms of the complex amplitudes of the original object and reference waves. Normally, this implies an object of limited thickness, such as transparency. To record a Fourier hologram, the object transparency is placed in the front focal plane of a lens, as shown in fig. 5, and illuminated with a collimated beam of monochromatic light. The reference beam is derived from a point
source also located in the front focal plane of the lens. The hologram is recorded on a photographic plate placed in the back focal plane of the lens[3].

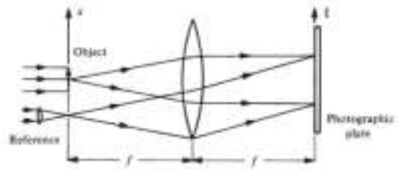

Fig. 5 Optical system used to record a Fourier hologram.

If the complex amplitude of the wave leaving the object plane is o(x, y), its complex amplitude at the photographic plate located in the back focal plane of the lens is:

$O(\xi,\eta)=F\{o(x, y)\}$. (1.10)

The reference beam is derived from a point source also located in the front focal plane of the lens. If $\delta(x+b, y)$ is the complex amplitude of the wave leaving this point source, the complex amplitude of the reference wave at the photographic plate can be written as:

$R(\xi,\eta)=\exp(-i2\pi\xi b)$. (1.11)

The intensity in the interference pattern produced by these two waves is, therefore,

$I(\xi,\eta)=1+|O(\xi,\eta)|2+O(\xi,\eta) \exp(i2\pi\xi b)+O^*(\xi,\eta) \exp(-i2\pi\xi b)$. (1.12)

To reconstruct the image, the processed hologram is replaced in the front focal plane of the lens, as shown in fig. 6, and illuminated with a collimated

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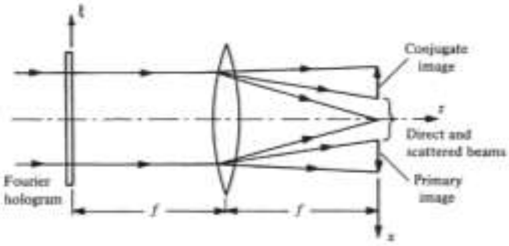


Fig. 6. Image reconstruction by a Fourier hologram.

Fourier holograms have the useful property that the reconstructed image does not move when the hologram is translated into its plane. This is because a shift of a function in the spatial domain only results in its Fourier transform being multiplied by a phase factor which does not affect the intensity distribution.

Reflection holograms

It is also possible to record a hologram with the object beam and the reference beam incident on the photographic emulsion from opposite sides. The interference fringes then form a series of planes within the emulsion layer, at a small angle to its surface and about half a wavelength apart. Such holograms, when illuminated with a point source of white light, reflect a sufficiently narrow band of wavelengths to reconstruct an image of acceptable quality.

A simpler way of recording such a hologram, with an object of limited depth, is to use the portion of the reference beam transmitted by the photographic plate to illuminate the object as in figure 7[4].

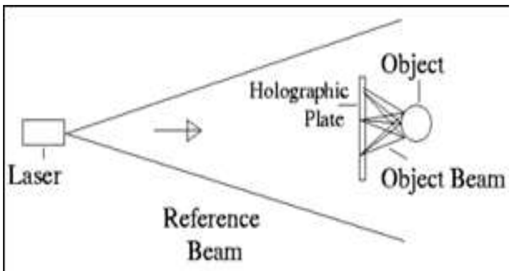
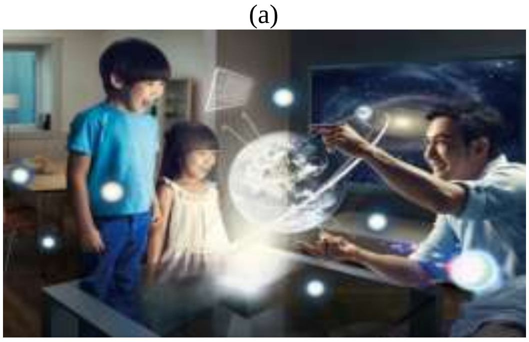


Figure 7. Hologram Reflection Process[5]

All that types of holograms had made great potential to make a real 3D hologram used nowadays in different life-styles as a business, entertainment, education, engineering designing, and a lot of other applications as in figures below.

(a)



(b)

Fig. 8. (a),(b) shows the use of smart phones in the implementation of Hologram technique in education and the possibility of applying in different places.

Fig.9. shows the use of hologram technique in the field of medicine


Fig.10. shows the use of hologram technique in advanced announcement and commercial field


Fig.11. shows the use of 3D hologram technique in engineering and business conferences field.

Ecosystem and telepresence holograms

Ecosystem holograms are created by projecting images onto a surface, usually a glass or clear plastic sheet. These hologram can be used to create 3D virtual environments that can be used for training, collaboration , or marketing purposes. Telepresence holograms are similar to ecosystem holograms, but they are interactive and can be controlled by a person who is not in the same room.

The ecosystem is the set of all the living organisms in a particular area, along with their physical environment. The term can also refer to the network of interactions between these organisms and their environment.

A telepresence hologram is a technology that allows user to interact with three-dimensional (3D) images of real people or objects. This type of hologram can be used for a variety of applications, including teleconferencing, gaming, and education[6].

Students and teachers can afford to communicate and interact even though they were very far from each other. Students might benefit from the realistic and convincing views of the study materials.

The hologram teacher appears to be in the classroom and can see and speak to the students as if they were all in the same room, which enables attractive and efficient interaction between student and teacher. Further to that, it can enhance the educational process by bringing famous characters to life again from the past, and they speak about themselves and/or explain something as an assistant teacher would be attractive to the students. However, those following animations have been testified realistically as in figure below; about the transmitting and receiving 3D hologram classroom using an ecosystem and telepresence technology[7].


Fig. 12 Transmitting room


Fig. 13. Receiving room.

full parallax at the same speed as horizontal-parallax-only (HPO). 3D telepresence is demonstrated with the HPO system, whereby 2D images were taken at multiple angles from one place and sent to another location using the Ethernet communication protocol, and then printed with the holographic set-up. To the best of our knowledge, this is the first demonstration of holographic 3D telepresence.

Our earlier rewritable 3D display19 used a continuous-wave frequency-doubled Nd: YAG laser as the recording source. The recording time was about one second per hogel, and the scanning system (used to shift from one hogel position to the next) needed to be stopped and damped each time to avoid vibration, resulting in a time-consuming process. As a result, the overall recording time for a 4-inch 3 4-inch hologram consisting of 120 hogels was of the order of 3 min. An erase time of
1 min was needed before refreshing the image. The system suffered from high sensitivity to ambient noise (such as vibration and air turbulence) and to thermal expansion, requiring a fully enclosed air-damped optical table[8].

III. EDUCATION TECHNOLOGY

At the most basic level, technology can be defined as a humanitarian issue and a philosophy of thinking which it involves applying technology information, skills, and experiences to solve human problems, meet their requirements, and expand their potential.

In education, technology is considered as a beneficial asset that can be more effective than traditional schooling. With the introduction of new technologies that require increased depth and breadth in technological studies, learning effectiveness has become a prominent topic in recent research.

"Education technology" is defined as "all methods, tools, materials, equipment’s, and rules employed in a specific educational system for academic objectives which have not been previously specified for the formulation and execution of the educational program."

Educational Technology, according to UNESCO, is a regular curve for the design and implementation of educational processes based on specified aims derived from research findings in the field of human education contact.

Students' learning styles are influenced by new learning strategies such as discovery learning, effective learning, experimental learning, multiple intelligences, and cooperative learning[9].

The impact of technology on education:

There is little doubt that the use of technology in education considerably aids the learner's self-efficacy, which adds to better educational outcomes.

The use of technology has affected the way people learn in these ways:

1. Keeping the data in a safe place.
2. Ability of offering convincing and realistic view of the user.
3. Using imagination techniques to excite and activate the brain, allowing kids to solve issues and create new things.
4. Inter campus activities and interaction are increased.
5. Ability of communicating users in different locations
6. Ensured that instructors who are planning sessions adhere to the guidelines for adopting the active learning technique, which
 include the four elements of flow: enjoyment, concentration, curiosity, and challenge.
7. Ability of attractive and efficient communication.
8. Ability of bringing famous characters as scientists, teachers, and so on, back to life[10].

IV.CONCLUSION

Technology and information will continue to have an impact on our academic, practical, and personal lives, as well as our ability to operate effectively at all levels; individuals must be conscious of these factors.

Information and technology It is no longer a realistic choice for universities to deal with the development of that technology or to include technology into the curriculum to present and design the material, but it should not be a difficult or complex process to deal with in order to set goals and apply technology.

Perhaps hologram technology will support the learning process even though it is not a "one size fits all"

solution. Preliminary results strongly suggested holograms will support the learning process. Indeed, the learning process is enhanced by allowing the student to see an object with a sense of reality, from any angle, "in three dimensions". Further suggested to continuous using the ecosystem and telepresence holograms as we saw in receiving and sending room, as extending the time of presentation and keep the room in health environment

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