Juni Khyat
(UGC Listed Journal)
ISSN: 2278-4632
Vol-9 Issue-1 No.01 January 2019

HOLOGRAPHY, A new Trends

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Abstract

Now a days, there is a growth of a large extend that which is unbelievable for us out of such advancements include computer graphics. Computer graphics is the creation of images or videos of objects either from physical world or which do not exist or maybe could never exist. Computer holography is an example of an amazing invention which is created using the advancements in computer graphics. It has many advantages over classical holography and thus give viewers a strong sensation of depth. Currently, there are no large holograms produced, it is then necessary to find some technique to broaden the size of the reconstructed image. The human skin get burnt due to the ionized air which are used to produce holograms. Thus, ultrasound radiation pressure is used to give a haptic feedback on the user's hand. The purpose of this paper is to analyze these innovations in holography.

Keywords: Computer graphics, Computer holography, Ultrasound Radiation Pressure, ionized air

1. Introduction

Holography is the science of producing holograms. A hologram is the interference pattern formed when a point source of light (the reference beam) of fixed wavelength encounters light of the same fixed wavelength arriving from an object (the object beam) which is recorded to a two-or three-dimensional medium. When the hologram is illuminated by the reference beam alone, the diffraction pattern recreates the wave fronts of light from the original object. Thus, the viewer sees an image indistinguishable from the original object. We are able to create holograms by many means. One of them is the computer generated hologram. It is also called as computer hologram. It is the method of digitally generating holographic interference patterns using the modern computer graphics.

2. Computer Hologram

The mathematics of holography is now well understood. Essentially, there are three basic elements in holography: the light source, the hologram, and the image. If any two of the elements are predetermined, the third can be computed. For example, if we know that we have a parallel beam of light of certain wavelength and we have a "double-slit" system (a simple "hologram"), we can calculate the diffraction pattern. Also, knowing the diffraction pattern and the de- tails of the double-slit system, we can calculate the wavelength of the light. Therefore, we can dream up any pattern we want to see. After we decide what wavelength we will use for observation, the hologram can be designed by a computer. This computer-generated holography (CGH) has become a sub-branch that is growing rapidly. For example, CGH is used to make holographic optical elements (HOE) for scanning, splitting, focusing, and, in general, controlling laser light in many optical devices such as a common CD player.

In classical holography, light waves from a real object are recorded on light-sensitive films by interference with reference waves. Object waves are reconstructed by diffraction of the interference fringes after chemical processing of the films. Thus, classical holography requires a real object to create its 3D holographic image. It is, therefore,

ISSN: 2278-4632
Vol-9 Issue-1 No.01 January 2019
impossible to create holograms of virtual 3D scenes such as provided by modern computer graphics and edit the 3D scene after recording the interference fringes.

An interference fringe is just a 2D image, and the reference wave can be expressed by a simple theoretical framework. In principle, therefore, we could easily produce the fringe pattern by numerical simulations of optical interference if we could obtain numerical data of the object waves from the 3D scene. However, calculating object waves from virtual 3D scenes is very hard work, even for modern computers. It sometimes takes several hundreds of hours or days to calculate object waves by conventional methods. Capturing light waves from real objects is also not easy, because the resolution and sizes of currently available image sensors do not meet the requirements for computer holography.

A novel computer algorithm has been developed that enables synthesis of holograms of completely virtual, computer generated 3D scenes in only several tens of hours. In addition, we developed a technique to capture light waves from real objects at high resolution and over a wide area to meet computer-holography conditions. This enables digitization of the entire process of classical holography. The resulting computer holograms give viewers a strong sensation of depth that has never been achieved with conventional 3D images.

An example for the 3D image reconstructed by a computer hologram is shown in fig.1. The 3D scene is composed of 3D objects and a 2D picture of the background. The shape of the 3D objects is given by polygon-mesh data, while the 2D picture is a digital image. See fig. 2.

Fig. 1 Optical reconstruction of the computer hologram 'Moai II'

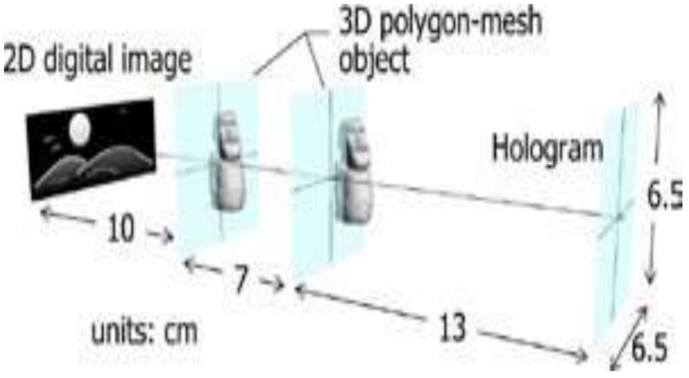

Fig. 2 3D scene of Moai II

In classical holography, light waves from real objects are digitally captured by synthetic-aperture phase-shifting digital holography, where the image sensor is moved to cover the area over which the object waves are spread.

ISSN: 2278-4632
Vol-9 Issue-1 No.01 January 2019

Whereas in computer holography, light waves from the object are numerically reconstructed by a simple fast-Fourier transform. Fourier transformation converts the sampling interval of the object waves to a suitably small value for construction of the computer hologram.

ISSN: 2278-4632
Vol-9 Issue-1 No.01 January 2019

The hologram's fringe pattern is computed by numerical interference with a reference wave usually a simple plane wave or a spherical wave and printed on a plate of chromium coated glass using laser lithography. This fabrication process is the same as that used for fabricating photo masks, e.g., for generating fine structures such as in large-scale integration. The fabricated computer holograms are chemically stable and do not suffer from aging degradation, unlike classical holograms.

When real objects are required to create 3D images in classical holography, computer holography needs only some calculations for creating the required interference pattern. It cannot reconstruct virtual 3D scenes and does not allow editing of the 3D scene after recording in classical holography while this technology can be replaced by modern, digital technologies.

3. Binary Holograms

The binary holograms are introduced to exploit the bandwidth of the SLM (Spatial light modulator) and for this the holograms have to be converted from grayscale to a binary format. So that we can produce large computer holograms. In order to preserve the 3D information of the object, the DBS (Direct Binary Search) algorithm is applied using the grayscale hologram itself as a reference image

Holographic data can be computed by a computer, or recorded directly from a real scene, but the holographic data captured are most of the time grayscale data. The Direct Binary Search algorithm (DBS) is a method that have been developed in order to convert a grayscale hologram into a binary hologram. The resulting binary hologram allows to reconstruct the object with a good accuracy, but only for one reconstruction plane. Further development are required for representing 3D surface. The DBS algorithm reconstructs the hologram instead of the object, and preserves therefore the 3D information of the data.

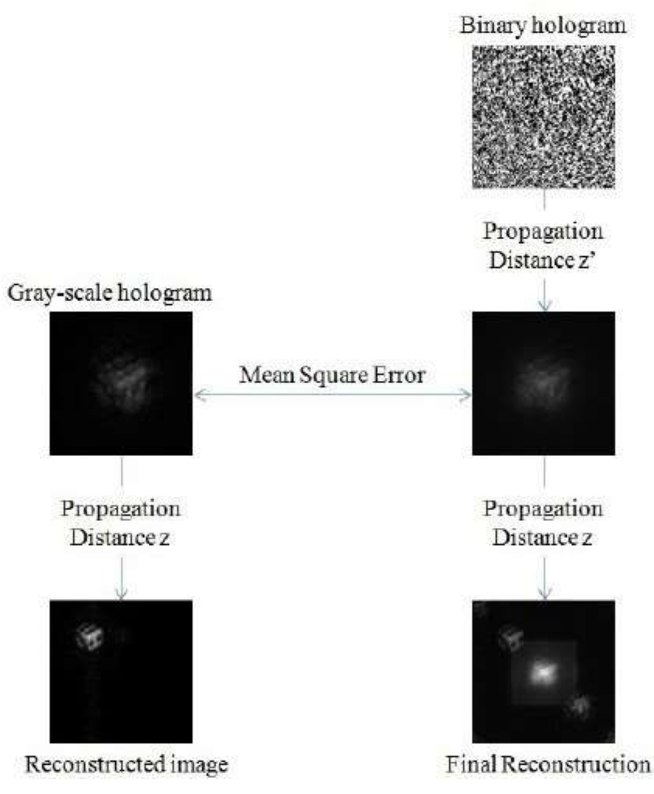

Fig. 3 The hologram itself as a reference image in order to preserve the 3D information

The main difference with the traditional method is that the MSE is not computed anymore between two images, but between two holograms, which means that the values compared may be complex. Reconstruction distance can be easily modified by the suggested approach. In the traditional method, the binary hologram can be calculated for an arbitrary distance as long as it fulfils the Fresnel approximation, and the distance z' can be similarly modified in the proposed method. The numerical simulations show the feasibility of the proposed method preserving the depth of the object after the computation of the binary hologram.

4. Touchable Hologram

Haptic feedback has become a common feature of recent technology, but such systems usually rely on stimulation of parts of the user's body via direct mechanical or acoustic vibration. Such an advancement in computer holography would amaze the entire world as the viewers can also touch and feel the hologram produced. In 2014, a new technique being developed by researchers at the University of Bristol promises to change all of this by using projected ultrasound to directly create floating 3D shapes that can be seen and felt in mid-air.

Building on previous work at the university, the researchers have used an array of ultrasonic transducers to create and focus compound patterns of ultrasound to shape the air at which it was directed. To make these shapes visible, the manipulated air was directed through a thin curtain of oil and a lamp was then used to illuminate it. According to the researchers, this results in a system that produces such accurate and identifiable shapes that users can readily match an image of a 3D object to the shape rendered by the prototype ultra- sound system.

In 2016, Scientists from Japan have created the first 'touch- able' hologram, enabling users to experience the illusion of touching objects that aren't really there. When a human hand comes into "contact" with the 3D image, the hologram emits ultrasonic radiation pressure, making the user feel they are actually touching the object. Scientists believe the next step will be to increase the use of the technology across all forms of communication, allowing users to give virtual hugs, hand- shakes and high fives through the internet.

5. Conclusion

A great advancement in the field of holography can be seen. By the help of computer holography, we are able to design our own 3D scene and so can create computer holograms out of that scene. The use of DBS algorithm helps us to produce large computer holograms, thus preserving 3D information. The haptic feedback in holography would be a greater advancement and that is now possible by the ultrasound radiation pressure. So that the created computer hologram can be felt by us now.

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