

# Defining and understanding holography physics essay



**ASSIGN  
BUSTER**

Holography, method of obtaining three-dimensional photographic images. These images are obtained without a lens, so the method is also called lensless photography. The records are called holograms (Greek holos, “whole”; gram, “message”). The theoretical principles of holography were developed by the British physicist Dennis Gabor in 1947. The first actual production of holograms took place in the early 1960s, when the laser became available. By the late 1980s the production of true-color holograms was possible, as well as holograms ranging from the microwave to the X-ray region of the spectrum. Ultrasonic holograms were also being made, using sound waves.

Holography is one of the remarkable achievements of a modern science and technology. Holograms have unique property to restore the high-grade volumetric image of real subjects. The word “holography” originated from the Greek words holos - whole and grapho - write, that means complete record of the image.

Holography represents photographic process in a broad sense of this word, essentially differs from a usual photo because there is a registration not only intensity in a photosensitive material, but also phase of light waves, scattered by the object and carried the complete information about three-dimensional structure of the object. As the medium of mapping of the reality, hologram has unique property: unlike usual photo, the holographic image can reproduce exactly three-dimensional copy of the original object. Such image with set of views, varied with change of supervision, has amazing realness and often looks like the real object. Unlike photography or painting, holography can render an object with complete dimensional

<https://assignbuster.com/defining-and-understanding-holography-physics-essay/>

fidelity. A hologram can create everything your eyes see - size, shape, texture and relative position. However, if you try to touch a holographic image, all you'll find is focused light.

### History of holography

Holography is known from 1947 when British (native of Hungary) scientist Dennis Gabor produced the theory of holography while he was trying to improve the resolution of electron microscope. Gabor coined the term which we know today i. e. holography by the greek word holos, which means "whole" while gramma means "message". Further development in the field was during the next period because light sources available at that time was not truly "coherent".

This problem was overcome in 1960 by Russian scientists N. Bassov and A. Prokhorov and American scientist Charles Towns with by the invention of the laser, whose pure, intense light was ideal for making holograms. In that year the pulsed-ruby laser was developed by Dr. T. H. Maiman. This laser system (unlike the continuous wave laser normally used in holography) emits a very powerful burst of light that lasts only a few nanoseconds (a billionth of a second). It effectively freezes movement and makes it possible to produce holograms of high-speed events, such as a bullet in flight, and of living subjects. The first hologram of a person was made in 1967, paving the way for a specialized application of holography: pulsed holographic portraiture.

In 1962 Emmett Leith and Juris Upatnieks of the University of Michigan recognized from their work in side-reading radar that holography could be used as a 3-D visual medium. In 1962 they read Gabor's paper and " simply <https://assignbuster.com/defining-and-understanding-holography-physics-essay/>

out of curiosity” decided to duplicate Gabor’s technique using the laser and an “ off-axis” technique borrowed from their work in the development of side-reading radar. The result was the first laser transmission hologram of 3-D objects (a toy train and bird). These transmission holograms produced images with clarity and realistic depth but required laser light to view the holographic image.

Their pioneering work led to standardization of the equipment used to make holograms. Today, thousands of laboratories and studios possess the necessary equipment: a continuous wave laser, optical devices (lens, mirrors and beam splitters) for directing laser light, a film holder and an isolation table on which exposures are made. Stability is absolutely essential because movement as small as a quarter wave- length of light during exposures of a few minutes or even seconds can completely spoil a hologram. The basic off-axis technique that Leith and Upatnieks developed is still the staple of holographic methodology.

Also in 1962 Dr. Yuri N. Denisyuk from Russia combined holography with 1908 Nobel Laureate Gabriel Lippmann’s work in natural color photography. Denisyuk’s approach produced a white-light reflection hologram which, for the first time, could be viewed in light from an ordinary incandescent light bulb.

Another major advance in display holography occurred in 1968 when Dr. Stephen A. Benton invented white-light transmission holography while researching holographic television at Polaroid Research Laboratories. This type of hologram can be viewed in ordinary white light creating a “ rainbow”

image from the seven colors which make up white light. The depth and brilliance of the image and its rainbow spectrum soon attracted artists who adapted this technique to their work and brought holography further into public awareness.

Benton's invention is particularly significant because it made possible mass production of holograms using an embossing technique. These holograms are "printed" by stamping the interference pattern onto plastic. The resulting hologram can be duplicated millions of times for a few cents apiece. Consequently, embossed holograms are now being used by the publishing, advertising, and banking industries.

In 1972 Lloyd Cross developed the integral hologram by combining white-light transmission holography with conventional cinematography to produce moving 3-dimensional images. Sequential frames of 2-D motion-picture footage of a rotating subject are recorded on holographic film. When viewed, the composite images are synthesized by the human brain as a 3-D image.

In 70's Victor Komar and his colleagues at the All-Union Cinema and Photographic Research Institute (NIFKI) in Russia, developed a prototype for a projected holographic movie. Images were recorded with a pulsed holographic camera. The developed film was projected onto a holographic screen that focused the dimensional image out to several points in the audience.

Holographic artists have greatly increased their technical knowledge of the discipline and now contribute to the technology as well as the creative

process. The art form has become international, with major exhibitions being held throughout the world.

The commonly and widely used way of imaging of the reality is the photography. A photograph is basically the recording of the differing intensities of the light reflected by the object and imaged by a lens.

However, information about dimensions of the object contained not only in amplitude (intensity), but also in a phase of light waves.

A great difference between holography and photography is the information recorded. This difference is why photographs are two dimensional (2-D) images while holograms are three dimensional (3-D) images. Photographs contain only one view point of an object. Our eyes need a minimum of two view points in order to see depth. Vision using two viewpoints of an object is called stereoscopic vision. Each eye receives a slightly different view point of an object, our brain combines the two and we perceive depth. We can fool our eyes into seeing photographs in three dimensions by taking two slightly different views of an object and allowing each eye to see only one image, the right image for the right eye and the left image for the left eye. We can do this with a stereoscope (for pictures) or with polarized glasses (for movies). The shortcoming of stereoscopic images is that when we move our head from side to side or up and down, we still only see the same two view points, whereas we should be seeing continuously changing viewpoints of the object. The image therefore doesn't quite appear to be three dimensional. In order to make a record of a three dimensional object we need to record this continuous set of viewpoints of the object.

Estimating sizes of the objects and considering shape and direction of shadows from these objects, we can create in our mind general representation about volumetric properties of the scene, represented in a photo. But, if sizes of the objects are identical and there are no shadows, volumetric content of the photographed scene is completely lost. For example, we can not define in the photo of snowflakes on a dark background, which of them is closer, and which of them is farther.

Holography is the only visual recording medium that can record our three-dimensional world on a two-dimensional recording medium and playback the original object or scene to the unaided eyes as a three dimensional image. The image demonstrates complete parallax and depth-of-field and floats in space either behind, in front of, or straddling the recording medium.