***Computer Generated Holograms***

Computer Generated Holography (CGH) is the method of digitally generating holographic interference patterns.

A holographic image can be generated e.g. by digitally computing a holographic interference pattern and

printing it onto a mask or film for subsequent illumination by suitable coherent light source.

Alternatively, the holographic image can be brought to life by a holographic 3D display

(a display which operates on the basis of interference of coherent light), bypassing the

need of having to fabricate a "hardcopy" of the holographic interference pattern each time.

***ADVANTAGES:***

Computer generated holograms have the advantage that the objects which one wants to show do

not have to possess any physical reality at all (completely synthetic hologram generation).

On the other hand, if holographic data of existing objects is generated optically,

but digitally recorded and processed, and brought to display subsequently, this is termed CGH as well.

Ultimately, computer generated holography might serve all the roles of current computer generated imagery:

holographic computer displays for a wide range of applications from CAD to gaming, holographic video and TV programs,

automotive and communication applications (cell phone displays) and many more.

***OVERVIEW:***

Holography is a technique originally invented by Hungarian physicist ***Dennis Gabor*** (1900-1979)

to improve the resolving power on electron microscopes. An object is illuminated with a

coherent (usually monochromatic) light beam; the scattered light is brought to

interference with a reference beam of the same source, recording the interference pattern.

CGH as defined in the introduction has broadly three tasks:

1. Computation of the virtual scattered wavefront

2. Encoding the wavefront data, preparing it for display

3. Reconstruction: Modulating the interference pattern onto a coherent light beam by technological means,

to transport it to the user observing the hologram. Note that it is not always justified to make

a strict distinction between these steps; however it helps the discussion to structure it in this way.

***WAVEFRONT COMPUTATION:***

Computer generated holograms offer important advantages over the optical holograms since

there is no need for a real object. Because of this breakthrough, a three-dimensional display

was expected when the first algorithms were reported at 1966. Unfortunately, the researchers soon realized

that there are noticeable lower and upper bounds in terms of computational speed and image quality and

fidelity respectively. Wavefront calculations are computationally very intensive; even with modern

mathematical techniques and high-end computing equipment, real-time computation is tricky.

There are many different methods for calculating the interference pattern for a CGH.

In the field of computational techniques the reported algorithms can be categorized in two main concepts.

***FOURIER TRANSFORM METHOD:***

In the first one the Fourier transformation is used to simulate the propagation of each plane of depth

of the object to the hologram plane. The Fourier transformation concept was first introduced by

***Brown*** and ***Lohmann*** with the detour phase method leading to cell oriented holograms.

A coding technique suggested by ***Burch*** replaced the cell oriented holograms by point holograms and made

this kind of computer generated holograms more attractive.

In a Fourier Transform hologram the reconstruction of the image occurs in the far field.

This is usually achieved by using the Fourier transforming properties of a positive lens for reconstruction.

So there are two steps in this process: computing the light field in the far observer plane,

and then Fourier transforming this field back to the lens plane.

These holograms are called Fourier Based Holograms.

***POINT SOURCE HOLOGRAMS:***

The second computational strategy is based on the point source concept, where the object is

broken down in self-luminous points. An elementary hologram is calculated for every point source and

the final hologram is synthesized by superimposing all the elementary holograms.

This concept has been first reported by ***Waters*** whose major assumption originated with ***Rogers*** who recognized

that a Fresnel zone plate could be considered a special case of the hologram proposed by Gabor.

But, as far as most of the object points were non-zero the computational complexity of the point-source

concept was much higher than in the Fourier transformation concept.