5.2 PRINCIPLE OF HOLOGRAM RECORDING

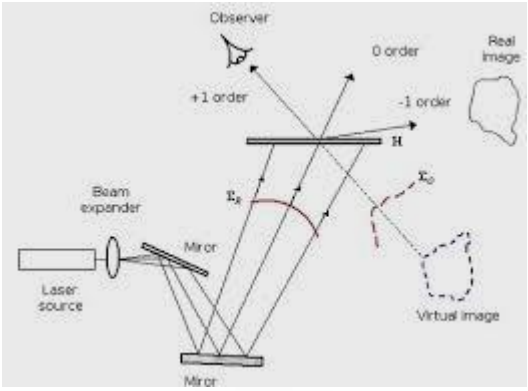

Figure 5.2.1 Hologram Recording Process

[Source: "Optical Fibre Communications" by J.M.Senior, Page:573]

Holography is a technique that enables a light field, which is generally the product of a light source scattered off objects, to be recorded and later reconstructed when the original light field is no longer present, due to the absence of the original objects.[20] Holography can be thought of as somewhat similar to sound recording, whereby a sound field created by vibrating matter like musical instruments or vocal cords, is encoded in such a way that it can be reproduced later, without the presence of the original vibrating matter.

Laser

Holograms are recorded using a flash of light that illuminates a scene and then imprints on a recording medium, much in the way a photograph is recorded. In addition, however, part of the light beam must be shone directly onto the recording medium - this second light beam is known as the reference beam. A hologram requires a laser as the sole light source. Lasers can be precisely controlled and have a fixed wavelength, unlike sunlight or light from conventional sources, which contain many different wavelengths. To prevent external light from interfering, holograms are usually taken in darkness, or in low level light of a different color from the laser light used in making the hologram. Holography requires a specific exposure time (just like photography), which can be controlled using a shutter, or by electronically timing the laser.

Apparatus

A hologram can be made by shining part of the light beam directly onto the recording medium, and the other part onto the object in such a way that some of the scattered light falls onto the recording medium.

A more flexible arrangement for recording a hologram requires the laser beam to be aimed through a series of elements that change it in different ways. The first element is a beam splitter that divides the beam into two identical beams, each aimed in different directions:

- One beam (known as the illumination or object beam) is spread using lenses and directed onto the scene using mirrors. Some of the light scattered (reflected) from the scene then falls onto the recording medium.
- The second beam (known as the reference beam) is also spread through the use of lenses, but is directed so that it doesn't come in contact with the scene, and instead travels directly onto the recording medium.

Several different materials can be used as the recording medium. One of the most common is a film very similar to photographic film (silver halidephotographic emulsion), but with a much higher concentration of light-reactive grains, making it capable of the much higher resolution that holograms require. A layer of this recording medium (e.g. silver halide) is attached to a transparent substrate, which is commonly glass, but may also be plastic.

Process

When the two laser beams reach the recording medium, their light waves, intersect and interfere with each other. It is this interference pattern that is imprinted on the recording medium. The pattern itself is seemingly random, as it represents the way in which the scene's light interfered with the original light source but not the original light source itself. The interference pattern can be considered an encoded version of the scene, requiring a particular key — the original light source in order to view its contents.

This missing key is provided later by shining a laser, identical to the one used to record the hologram, onto the developed film. When this beam illuminates the hologram, it is diffracted by the hologram's surface pattern. This produces a light field identical to the one originally produced by the scene and scattered onto the hologram. The image this effect produces in a person's retina is known as a virtual image.

CONDITION FOR RECORDING A HOLOGRAM

A suitable object or set of objects a suitable laser beam part of the laser beam to be directed so that it illuminates the object (the object beam) and another part so that it illuminates the recording medium directly (the reference beam), enabling the reference beam and the light which is scattered from the object onto the recording medium to form an interference pattern a recording medium which converts this interference pattern into an optical element which modifies either the amplitude or the phase of an incident light beam according to the intensity of the interference pattern.

An environment which provides sufficient mechanical and thermal stability that the interference pattern is stable during the time in which the interference pattern is recorded. The object should be fully exposed to radiation. The photographic plate should have i) high resolution ii) high sensitivity iii) wide spectral range.