Fig. 23.13

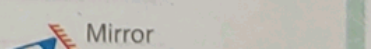
23.9. APPLICATIONS

Holography can be used for a broad range of applications in different fields. It is not possible to describe all of them here. Only some typical applications are discussed here.

1. **Security**: One of the most popular areas for the use of holograms is the security and product authentication. The presence of holograms indicates the authenticity of these items. They provide a powerful obstacle to counterfeiting. The security holograms have proven to be unsurpassed when added to documents, anti-counterfeiting, tamper-proofing, customizing ticket protection, identification documents including credit and phone cards, drivers licenses etc.
2. **Three-dimensional photography**: One of the most obvious applications of holography is the production of a three-dimensional photograph, with the distance and orientation of each point of the object recorded in the image.
3. **Microscopy**: Holography can be used in techniques of microscopy. It is possible to obtain a magnified image of an object if recording is done with light of smaller wavelength and reconstruction with light of longer wavelength. Smaller areas in an object can be examined in greater detail. This has great potential in observing micro-objects such as blood cells, amoebas, cancer affected tissues etc.
4. **Character recognition**: Holography can also be used for character recognition. The complicated wave front from an object is generated from a hologram by the simple wave front of the reference beam. The process is reversible so that reference wave can be generated by the object wave. This principle forms the basis of holographic pattern recognition. This could be used to identify fingerprints etc.
5. **Data storage**: Holograms can also be used for data storage devices and hence are of much use in computer technology. A large amount of information such as 10^{12} letters/digits can be stored in a cubic cm of a volume hologram. These memories have long lifetime because a small mechanical damage to the portion of a hologram will not erase the stored information.
6. **Photolithography:** Holography is used in the production of photographic masks used to produce microelectronic circuits.
7. **Holographic projection** is used to display flight information at the pilot's eye level in an airplane cockpit.
8. **Holographic interferometry:** One of the most important applications of holography has been in interferometry. **Holographic interferometry** is an optical technique to visualize in a dark environment small deformations (200 nm to 100 μm) of objects. It is applied to objects, which are placed in a vibration-free set-up.

   Holographic interferometry is used in vibrational analysis, structural analysis, stress and strain evaluation etc. There are three basic methods of holographic interferometry. They are known as real time, multiexposure and time-average holography.

Real time holography allows one to



23.7. IMPORTANT PROPERTIES OF HOLOGRAM

1. In an ordinary photograph each region contains separate and individual part of the original object. Therefore, destruction of a portion of a photographic image leads to an irreparable loss of information corresponding to the destroyed part. On the other hand, in a hologram each part contains information about the entire object. From even a small pat of the hologram the entire image can be reconstructed if only with a reduced clarity and definition of the image. Therefore, a hologram is a reliable medium for data storage.
2. It is not useful to record several images on a single photographic film. Such a record cannot give information about any of the individual images. On the other hand, several images can be recorded on a hologram. Therefore the information holding capacity of a hologram is extremely high. While a 6×9 mm photograph can hold one printed page, a hologram of the same size can store up to 300 such pages.
3. On a hologram information is recorded in the form of interference pattern. The type of the pattern obtained depends on the reference beam used to record the hologram. The information can be decoded only by a coherent wave identical to that of the reference wave. The reference wave can be chosen appropriately. Consequently without the knowledge of the shape of the reference wave front the information encoded in the form of interference pattern on the hologram cannot be deciphered.
4. The reconstruction of the image of the hologram can be done with reference beam of any wavelength if it is coherent and identical to the original reference beam. If the wavelength λ of the reconstructing beam is greater than that λ_0 of the reference beam, the reconstructed image will be a magnified image. The magnification will be proportional to the ratio of the two wavelengths.