Answer on Question #60462, Physics / Optics

Discuss the importance of hologram in (i) information storage, and (ii) pattern recognition.

Solution:

Hologram – registered on photographic plate the interference pattern which is formed by two coherent beams of light: one goes from the source (reference beam), the second reflected from an object illuminated by the same source (subject beam).

(i) information storage

Holographic data storage is a technique that can store information at high density inside crystals or photopolymers. It is a potential technology in the area of high-capacity data storage. Magnetic and optical data storage devices rely on individual bits being stored as distinct magnetic or optical changes on the surface of the recording medium. Holographic data storage records information throughout the volume of the medium and is capable of recording multiple images in the same area utilizing light at different angles. Additionally, whereas magnetic and optical data storage records information a bit at a time in a linear fashion, holographic storage is capable of recording and reading millions of bits in parallel, enabling data transfer rates greater than those.

Holographic data storage contains information using an optical interference pattern within a thick, photosensitive optical material. Light from a single laser beam is divided into two, or more, separate optical patterns of dark and light pixels. By adjusting the reference beam angle, wavelength, or media position, a multitude of holograms (theoretically, several thousands) can be stored on a single volume.

The stored data is read through the reproduction of the same reference beam used to create the hologram. The reference beam's light is focused on the photosensitive material, illuminating the appropriate interference pattern, the light diffracts on the interference pattern, and projects the pattern onto a detector. The detector is capable of reading the data in parallel, over one million bits at once, resulting in the fast data transfer rate. Files on the holographic drive can be accessed in less than 0.2 seconds.

While many holographic data storage models have used "page-based" storage, where each recorded hologram holds a large amount of data, more recent research into using submicrometre-sized "microholograms" has resulted in several potential 3D optical data storage solutions. While this approach to data storage can not attain the high data rates of page-based storage, the tolerances, technological hurdles, and cost of producing a commercial product are significantly lower.

(ii) pattern recognition

The use of optical security elements (holograms) is considered by specialists as an effective and reliable protection against counterfeiting. Optical elements of security are on diffractive optical structures. They are in a layer of foil. To fake or copy these elements is almost impossible. To produce holograms used a number of very complex and precise processes, including laser interference photos registration of objects, Fourier coding, computer synthesis, raster record. Specialist carefully chooses the complex of operations. At one hologram can be written dozens of images.

Pattern recognition – one of the most interesting and promising applications of holography. It is based on the ability of hologram to allocate of group items those items which have "images" recorded on this hologram. The hologram will miss only the portion of the spectrum, which is close to the range recorded on it. Hologram "respond" only by the image of one of "their" objects, provided that it is installed in the appropriate position. Therefore using holograms can automate the process of pattern recognition.