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Holographic Data Storage

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Abstract **-** In responsible of rapidly changing face of computing and demand for physically smaller with greater capacity and high band width, the holographic memory came into existence. holographic data storage using volume holograms offers high density and fast read out. A single holographic device can store more than 100s of CDs. Holographic data storage is a high data storage capacity technology that enables data storage by creating holographic images of the each data on the supported medium. Holographic data storage records information throughout the volume of the medium and is capable of recording multiple images in the same area and utilizes light at different angles .

Keywords - Smaller, High Capacity, Density, Medium, Recordings.

I. INTRODUCTION

Due to vast increase of storage or data there is demand for the increase of storage capacity of small device foot print .what is hologram? The word hologram derived from the Greek word HOLOS meaning WHOLE and GRAM means MESSAGE .IT is a 3d image formed by the interference of light beam from a laser or coherent light source.What is holographic data storage?It is an advance data storage concept that stores information in the form of holographic images.

It is an volumetric approach of storing data.it can store 1-4 TB of data on asugar It cube sized crystal.it is a potential technology in the area of high capacity data storage currently dominated by magnetic data storage and conventional official data storage Holographic data storage has several characteristics that are unlike those of any other existing storage technologies.Most exciting, of course, is the potential for data densities and data transfer rates exceeding those of Magnetic data storage. In addition, as in all other optical data storage methods, the density increases rapidly with decreasing laser wavelength.

Figure .1

In contrast to surface storage techniques such as CD-ROM, where the density is inversely proportional to the square of the wavelength, holography is a volumetric technique, making its density proportional toone over the third power of the wavelength.

II. RECORDING HOLOGRAP HIC DATA

Holographic data storage contains informationusing the optical interference pattern within thick photosensitive optical material. This can be done by intersecting two coherent laser beams within a storage material. The first called the object beam contains the information to be stored , the second called the reference beam is designed to be simple to reproduce .The light that comes from a single laser beam is divided into two or many and separates optical pattern of dark and light pixels after adjusting the reference beam angle and wavelength.

In the Figure 2, supposition of spherical wave from one bit with coherent plane wave reference beam forming interference pattern

Here the photosensitive medium exposed to the interference pattern.C) Record of interference grating is stored when there is a change in the refractive properties of the medium.

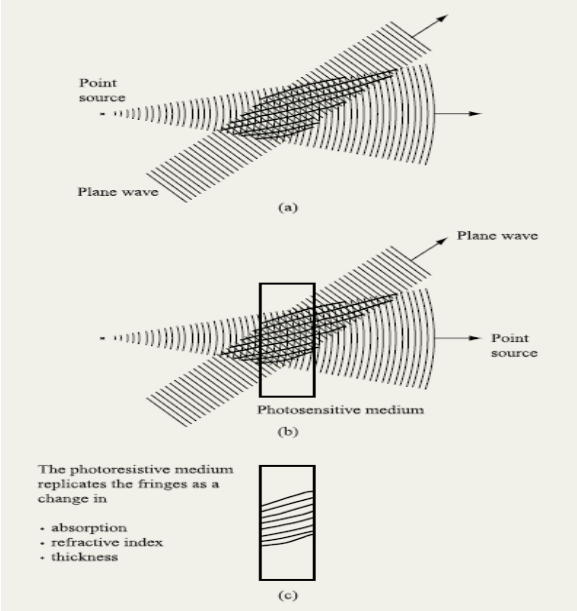

Figure.2 recording data

III. READING THE HOLOGRAPHIC STORED DATA

The holographic stored data can be read by creating the hologram. The reference beams light is when focused on the photosensitive material describing the interference pattern the light diffract through interference pattern and projects it on the detector.

- The detector can read the data in parallel. The detector is capable of reading the data in parallel.

- It can read one million bits at once which results in fast data transfer rate and the files can accused in 0.2 seconds.

Figure 3 -A) Acted by stored interference pattern to reconstruct the original spherical wave front of the object beam

B) The diverging object beam is diffracted by the stored interference pattern to reconstruct the original plane wave reference beam.

- This beam is focused to a detector and represents an optical measurement of correlation between stored data and illuminating object beam.

C) Reference beam is diffracted by stored interference pattern to reconstruct a copy of the original object beam.

- When the phase returns to original point of origin, the stored bit value can be read without high quality imaging system.

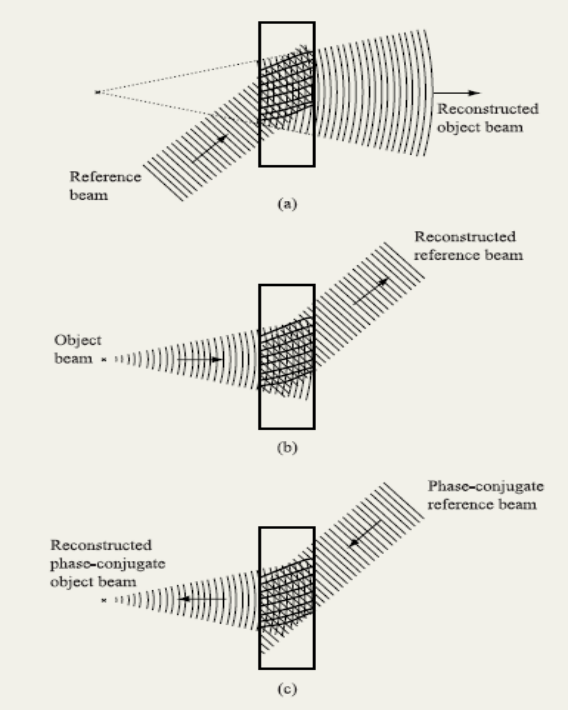

Figure.3 reading data

IV. BASIC HOLOGRAPHIC DATA STORAGE SYSTEM

Data are imprinted onto object beam with pixelated input device called a spatial light module. The image of thedata page at the camera must be as close as possible toperfect. Any optical aberrations in the imaging system ormisfocus of the detector array would spread energy fromone pixel to its neighbors. Optical distortions (wherepixels on a square grid at the SLM are not imaged to asquare grid) or errors in magnification will move a pixelof the image off its intended receiver, and either ofthese problems (blur or shift) will introduce errors in the retrieved data. To avoid having the imaging system dominate the overall system performance, near-perfect optics would appear to be unavoidable, which of course

would be expensive. However, the above-mentionedreadout of phase-conjugated holograms provides a partial solution to this problem. Here the reconstructed data page propagates backward through the same optics that were used during the recording, which compensates for most shortcomings of the imaging system.

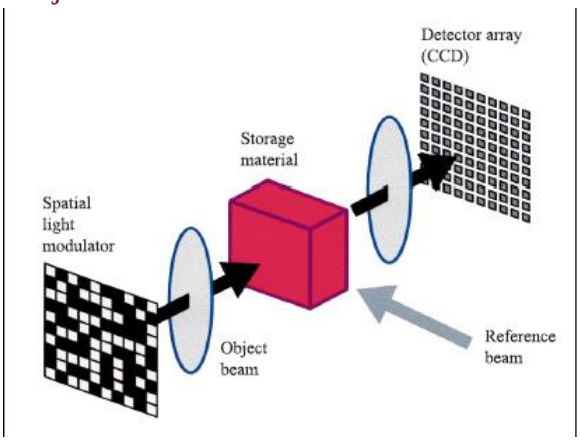

Figure.4.holographic system

However, the detector and the spatial light modulator must still be properly aligned.A rather unique feature of holographic data storage isassociative retrieval: Imprinting a *partial* or search data pattern on the object beam and illuminating the stored holograms reconstructs all of the reference beams that were used to store data. The intensity that is diffracted by each of the stored interference gratings into the corresponding reconstructed reference beam is proportional to the similarity between the search pattern and the content of that particular data page. By determining, for example, which reference beam has the highest intensity and then reading the corresponding data page with this reference beam, the closest match to the search pattern can be found without initially knowing itsaddress.Because of all of these advantages and capabilities,age has provided an intriguing alternative to conventional data storage techniques for three decade

V. HARDWARE FOR HOLOGRAPHIC DATA STORAGE

Figure 4 shows the most important hardware components in a holographic storage system: the SLM used to imprint data on the object beam, two lenses for imaging the data onto a matched detector array, a storage material for recording volume holograms, and a reference beam intersecting the object beam in the material. What is notshown in Figure 4 is the laser source, beam-forming optics for collimating the laser beam, beamsplitters for dividing the laser beam into two parts, stages for aligning the SLM and detector array, shutters for blocking the two beams when needed, and waveplates for controlling polarization. Assuming that holograms will be angle-multiplexed(superimposed yet accessed independently within the same volume by changing the incidence angle of the reference beam), a beam-steering system directs the reference beam to the storage material. Wavelength multiplexing has some advantages over angle-multiplexing, but the fast tunable laser sources at visible wavelengths that would be needed do not yet exist. The optical system shown in Figure 3, with two lenses separated by the sum of their focal lengths, is called the "4-f" configuration, since the SLM and detector array turn out to be four focal lengths apart. Other imaging systems such as the Fresnel configuration (where a single lens satisfies the imaging condition between SLM and detectorarray) can also be used, but the 4-f system allows the high numerical apertures (large ray angles) needed for high density. In addition, since each lens takes a spatial Fourier transform in two dimensions [5], the hologram stores the Fourier transform of the SLM data, which is then Fouriertransformed again upon readout by the second lens. This has several advantages-Point defects on the storage material do not lead to lost bits, but result in a slight lossin signal-to-noise ratio at all pixels; and the

storagematerial can be removed and replaced in an offsetposition, yet the data can still be reconstructed correctly. In addition, the Fourier transform properties of the 4-f system lead to the parallel optical search capabilities offered by holographic associative retrieval. The disadvantages of the Fourier transform geometry come from the uneven distribution of intensity in the sharedfocal plane of the two lenses.

VI. CHARACTERISTICS

Holographic data storage has several characteristics that are unlike those of any other existing storage technologies. Most exciting, of course, is the potential for data densities and data transfer rates exceeding those of magnetic data storage. In addition, as in all other optical data storage methods, the density increases rapidly with decreasing laser wavelength. In contrast to surface storage techniques such as CD-ROM, where the density is inversely proportional to the square of the wavelength, holography is a volumetric technique, making its density proportionalto one over the third power of the wavelength. In principle, laser beams can be moved with no mechanical components, allowing access times of the order of 10 ms, faster than any conventional disk drive will ever be able to randomly access data. As in other optical recording schemes, and in contrast to magnetic recording, the distances between the "head" and the media are very large, and media can be easily removable. In addition, holographic data storagehas shown the capability of rapid parallel search through the stored data via associative retrieval.On the other hand, holographic data storage currently suffers from the relatively high component and integration costs faced by any emerging technology. In contrast, magnetic hard drives, also known as direct access storage devices (DASD), are well established, with a broad knowledge base, infrastructure, and market acceptance.while the latter two are designed for WORM materials, which are much easier to develop but must support data retention times as long as tens of years. The first scenario takes advantage of rapid optical access to a stationary block of media, resulting in a random-access time of the order of 10 ms. The capacity is limited to about 25 GB by the size of the block of media that can be addressed by simple, inexpensive optics. Such a device could bridge the gap between conventional semiconductormemory and DASD, providing a nonvolatile holographic cache with an access time that is between DASD and dynamic random-access memory (DRAM). Using the same optical components but replacing the stationary block of media with a rotating disk results in performance characteristics similar to those of a disk drive, albeit with terabytes (1012 bytes) of capacity per platter . In the CD-ROM type of embodiment [Figure 20(c)], holographic data storage takes advantage of the fact that single-exposure full-disk replication has been demonstrated . The player forthe holographic ROM is conceptually very simple: The photodiode from a conventional ROM player is replaced by a CMOS camera chip, and the reconstructed data page is then imaged with suitable optics onto that camera. Combining one of the DASD-type R/W heads andpossibly a number of CD-ROM-type readers, a robotic picker, and sufficient tiles of media, a data warehouse with petabyte (1015 bytes) capacity in a standard 19-inch rack is conceivable [Figure 20(d)]. While the access time to any of the stored files is determined by the robotic picker and will be of the order of tens of seconds, the aggregate sustained data rate could be enormous. In this scenario, the relatively high component cost of a read/writeholographic engine is amortized over a large volume of cheap media to obtain competitive cost per gigabyte. Will one of these scenarios with data stored in holograms materialize and become reality in theforeseeable future? In collaboration and competition with a large number of scientists from around the globe, we continue to study the technical feasibility of holographic storage and memory devices with parameters that are relevant for world applications. Whether this research will one day lead to products depends on the insights that we gain into these technical issues and how well holography can compete with established techniques in the marketplace.

VII. IT'S LONGEVITY

Holographic data storage provides a company the method to preserve and archive information. The write-once, read many approach to data storage would ensure content security, preventing the information from being overwritten or modified. Manufacturers believe this technology can provide safe storage for content without degradation for more than 50 years, far exceeding current data storage options. Counterpoints to this claim are that the evolution of data reader technology has – in the last couple of decades – changed every ten years. If this trend continues, it therefore follows that being able to store data for 50–100 years on one format is irrelevant, because you would migrate the data to a new format after only ten years. However, claimed longevity of storage has, in the past, proven to be a key indicator of shorter-term reliability of storage media. Current optical formats – such as CD – have largely lived up to the original longevity claims and have proved to be more reliable shorter term data carriers than the floppy disk and DAT media they displaced.

CONCLUSION

From this paper we understand 3d optical data storage are in the state of demand and research. From the study it is concluded that holographic storage of data helps in terabytes of storage and less space with high speed. holographic storage of data is the method which has the capability to store more than 100GB of data .in comparison of other data storage 3D optical data storage is more beneficial .They can be used for satellite data storage defense and digital libraries which requires large amount of data .holographic data storage is still a developing technology that hasn't been introduced to the public and government sectors. After 3D there can be a possibility of 4D and 5D optical data storage.

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