

Holographic Data Storage Technology

The future of Data Storage

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Abstract—In the present times technological advancement has grown at rapid rate. Today most of the people are using smart devices which comprises of various kinds of technologies. One of the most important factor in using technology is to store digital data. Presently most of the work are done using digital devices such as computers and mobiles and people need to store their data in devices but the device has limited amount of storage. So need arises to store more amount of data using less space. For this purpose we need to invent storage technologies which helps people to store more amount of data. In order to meet demands of greater storage there are various storage technologies such as different types of ROM, optical storage discs, USB flash drives which uses different technologies to store data. This paper focuses on Holographic data storage technology which helps people to store large amount of data.

Keywords-storage, disc, mobiles, ROM, Flash drive, Holographic storage

I. INTRODUCTION

The effectiveness of present computing devices are totally dependent on the types of the memory used in the system. The capacity of device is measured by the amount of data it can store. Present device uses different kinds of flash storage technologies which can store limited amount of data. The optical storage such as CD, DVD and Blue-Ray which are currently used in computing systems follows 2-dimensional storage medium. These devices has increased its storage capacity but with the limitation that it can store data in layers on the disc.[2]. They store data as reflective marks in series on internal surface of discs. In 3D storage, there is no limitation for layers: To grow capacity of storage one need to add volume. Presently two types of 3D storage available: simple 3D storage and Holographic data storage.

II. OPTICAL READING TECHNOLOGY

Optical data storage is a good replacement for magnetic data storage. At present speed of data access is very slow as compared to speed of CPU execution, because now a days devices contains faster CPU and it requires faster execution of data form storage[1].

From past, there were many optical storage medium available. It started its journey with laser disc and then shifted to CD (compact disk) which contains maximum upto 700 MB of storage, after that more storage has been added to the media and DVD (Digital Versatile Disk) came into exists which has 4.7 GB of storage capacity. From DVD the technology has changed and storage capacity again increased and Blu-Ray disc came into the market which contains 25 GB storage capacity. Since these all are 2D storage devices, they are cheap and stable. The overall storage capacity was increased with each new generation of devices. Holographic data storage is a new technology in the field of high-capacity data storage currently conquered

by magnetic data storage and predictable optical data storage. Magnetic and optical data storage devices depends 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[4].

III. PRINCIPLE OF HOLOGRAPHIC STORAGE TECHNOLOGY

Holographic storage works on the principle of storing a sequence of distinct data within the thickness of the media. The storage process starts when a laser beam is split into two signals. One beam is used as a reference signal. Second beam, which is known as the data-carrying beam, is passed through a device called a SLM (spatial light modulator) which acts as a fine shutter system, passing and blocking light at points corresponding to ones and zeroes. The reference beam is then reflected to impose on the data-carrying beam within the media. This creates a three-dimensional refraction pattern (the "hologram") that is captured in the media. Holographic storage uses circular media to store data which is same as blank CD or DVD which rotates to accept data with a continuous circular data path. When the write process is finished, data is read using the reference beam to illuminate the refraction.

This 3D technology of data recording is an important difference between holographic storage and traditional CD or DVD recording. Traditional optical storage media uses a single laser beam to write data in two dimensions with a continuous circular data path. On the other hand, prototype holographic storage products save 1 million pixels at a time in discrete image, and these images are also called pages, which form tiny cones through the thickness of the light-sensitive media. Present holographic media can store over 4.4 million individual pages on a disc.

Now a day, holographic storage is a Write Once Read Many (WORM) technology that depends on light-sensitive media wrapped in removable protective cartridges. [5]

IV. WORKING OF HOLOGRAPHIC STORAGE

In holographic data storage, the whole page of information is stored at one time as an optical intervention pattern within a thick, photosensitive optical material. This is the reasons why holographic data storage is able to break through the density limits of traditional storage and attain data transfer rates considerably higher than existing optical storage devices:

- Holographic storage write and read data parallyly with a single flash of light while other optical storage technology stores one data bit at a time.
- Holographic storage is capable of breaking the limit of conventional storage by going above the technique to record only on the surface to the recording through the full depth of the recording medium.

The grouping of high storage mediums, fast data transfer rates, and strong, consistent and low cost media, make holography balanced to become a convincing option for next-generation data storage solution of the commercial organization, medical field , government sectors and telecom industries.

In this type of technology, holographic storage uses two laser beams, one is reference beam and other is data beam to create a compatible pattern at a medium where the two beams interconnect. This intersection causes a stable physical or chemical change which is stored in the medium. This is the

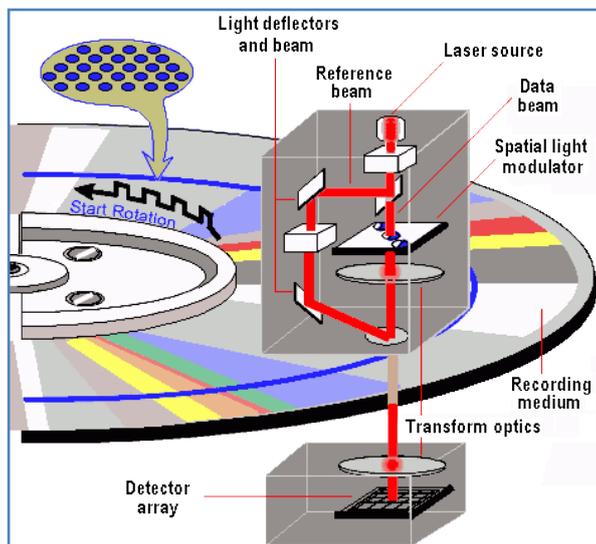


Fig-1:working of holographic disk[7]

write sequence. While reading data, the action of the reference beam and the interference pattern stored in the medium regenerate the data beam which may be sensed by a detector array. The medium may be anything such as a rotating disk which contains a polymeric material, or an optically sensitive with crystal material.

A. Writing mechanism of Holographic data storage

Two Lasers beams Write the Hologram

The first data laser beam is penetrated through a matrix of Liquid Crystal Display shutters which is known as Spatial Light Modulator (SLM) into an optical section.

Based on the binary pattern of data, the shutters are opened and closed accordingly. If we use a matrix of 500 by 500 bits, it can store 250000 bits.

Second beam that is reference laser beam is penetrated at some angle and intersects with data laser beam in the optical region.

If the reference laser beam changes the angle and frequency, other hologram is written in the region which overlaps and fills the 3D volume same as first hologram

As per theory concepts it can write millions of pages in the same optical area and as per data the first holographic optical drive has recorded 330 holograms.

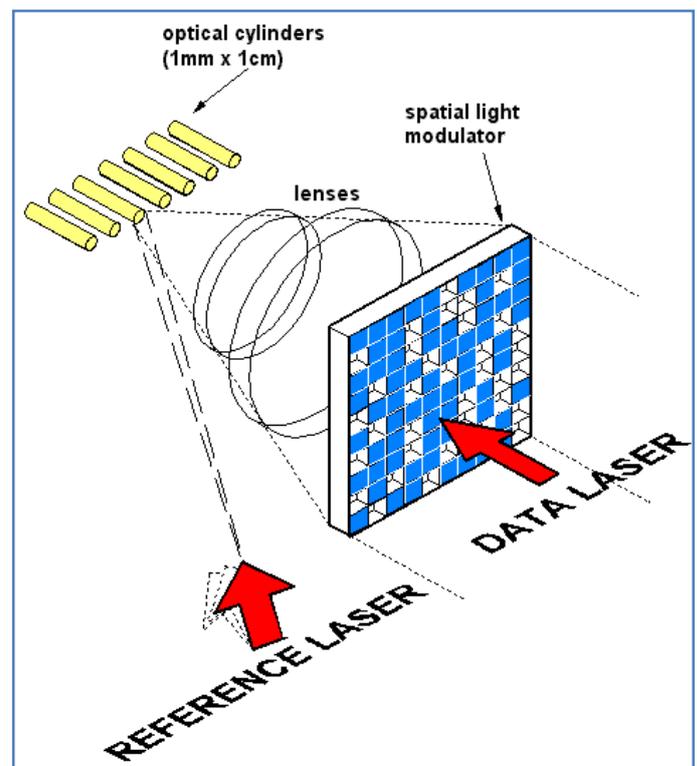


Fig-2: Writing data into disc[6]

B. Reading mechanism of Holographic data storage

One single Laser beam Reads the Hologram

To read the page the reference laser beam is directed back into the hologram and the light is diffracted into the binary data and this data is sensed by the sensors.

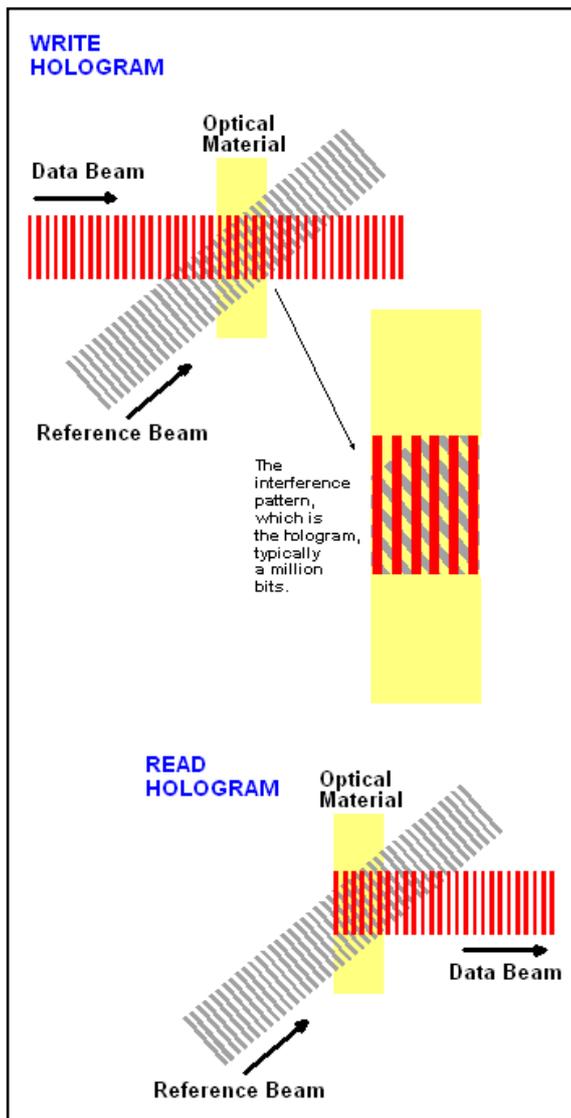


Fig-3: Reading mechanism[6]

V. STRUCTURE OF HOLOGRAPHIC DISK

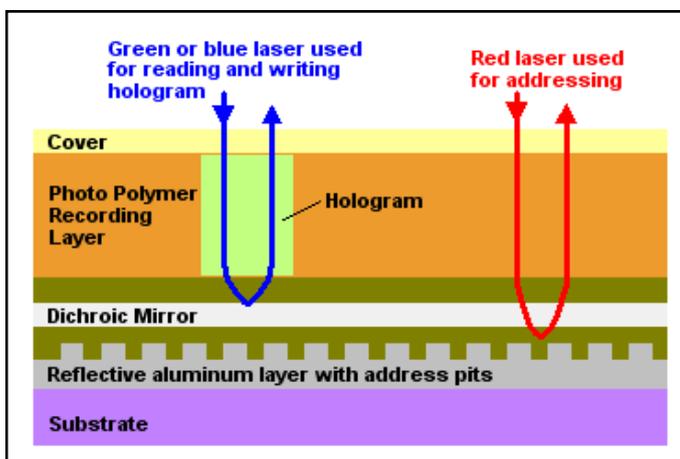


Fig-4: internal structure of Holographic disk[8]

The disk contains a thick recording layer which lies between two layers and comprises of a diachronic mirror which emits the blue colored and green colored lights which carries the holographic data and it allows the red light to penetrate through to gather servo information.

The thick layer is about 1 mm in thickness and is made up of holographic material. Number of holograms can be stored at every location of surface of disk. These locations are organized with circular tracks, in which the head motion selects a track, and the disk accesses each track with each rotation. Number of holograms can be stored by increasing the thickness of the layer which results in the higher surface density. Practically it is desirable to manufacture disk of 1 mm which consists of density of 100 bps. The important factor is the configuration of surface density as compared to volume density because it stores the data in 3D. To multiplex holograms on the disk the Angle multiplexing technology is used. Because of angle scanner, the read head becomes very large in size and also becomes heavy for fast access to holograms on various disk. The reference beam is convenient option because it can gain same density without any heavy beam deflector. This can be achieved by making the round reference beam.

VI. DIFFERENCE BETWEEN HOLOGRAPHIC DISK AND TRADITIONAL OPTICAL DISK[8]

HOLOGRAPHIC DISK	TRADITIONAL OPTICAL DISK
It can store more than 1TB of data by using the overlapping pattern to store hologram.	It can store data using side – by- side pattern.
Instead of using thin layer like traditional disk holographic disk store information in the whole volume of disk using thick layers.	Traditional DVD uses dual layer to store data.
It can transfer data at the rate of 1GB/second	The traditional DVD can transfer data at maximum 30MBPS
Using one pulse of light holographic disk can store and retrieve whole page of data which is approx. 600000 bits of information.	In DVD it can store and retrieve 1 bit of data using one pulse of light.

VII. ADVANTAGES OF HOLOGRAPHIC STORAGE

- Long storage life – it can retain data upto 50 year.
- Very useful for the field in which complex data access required.
- Large storage Capacity – can store upto 1 TB of data per inch of storage disk.
- Fast data access time
- Very high data transfer rates – Up to 1GB per seconds which is 40 times faster then a DVD.
- Extremely optimum for small portable devices because of low power consumption (10GB/Watt) and high data storage capacity for smaller dick sizes.

VIII. DISADVANTAGES OF HOLOGRAPHIC DATA STORAGE:

- As compared to current data storage technology, the holographic data storage is costly.
- Due to high cost industries may not take interest to invest in this kind of technology.

IX. CONCLUSION

By studying holographic storage technology it is concluded that we can store very large data with high speed using very less space. This technology will bring great revolution in the field of data storage technology. This storage technology will also help to environment because it requires very less number of disks to store large amount of data. It should become

the option for storing high definition data for distribution also. As the data access speed should also increased with holographic storage we can access more amount of data in less amount of time. This holographic data storage technology will definitely bring huge revolution in data storage industry.

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