

Holographic Data Storage

Komal Daiya¹, Bharti Chouhan ², Pankaj Rathi³

Electronics & Communication Engineering, Shrinathji Institute of Technology & Engineering, Nathdwara Rajasthan, India¹
 Electronics & Communication Engineering, Shrinathji Institute of Technology & Engineering, Nathdwara Rajasthan, India²
 Electronics & Communication Engineering, Shrinathji Institute of Technology & Engineering, Nathdwara Rajasthan, India³

¹k.daiya@yahoo.com, ²bhartichouhan1993@gmail.com, ³rathi.panks@gmail.com

Abstract - This analysis paper examines the new technology of Holographic knowledge storage. It highlights the importance and wish of this technology. The demand for will increase within the capability and speed of information storage tests the bounds of typical technologies and drives the hunt for new approaches. The growing demands of high definition digital video content, fastened content knowledge, and compliance and security application can shortly outstrip the capabilities of current storage technologies to stay up the demand. Clearly a replacement storage paradigm is required to fulfill the growing storage demands. The decreasing price of storing knowledge and therefore the increasing storage capability of identical tiny device footprint are key enablers of this revolution. whereas current storage wants square measure being met, storage technology should still improve so as to stay pace with the speedily increasing demand Holographic knowledge Storage may be a meter approach that, though planned decades ago, has created recent progress towards usefulness with the looks of lower-cost sanctioning technologies, important results from long analysis efforts and progress in holographic recording materials.

Index Term: Content distribution, Holographic data storage, HVD, Spatial light modulator, Three dimensional storage.

I. INTRODUCTION OF HOLOGRAPHY

Holography is that the methodology we have a tendency to use to record patterns of sunshine. Exposure is from the Greek word holes, which means whole and gamma which means message. As a result of a holograph could be a complete image of an artless object. Optics captures each intensity level and part, distinctive it from photography, which may solely record intensity. These patterns are reproduced as a 3 dimensional image referred to as an exposure. Whereas Hungarian scientist physicist fancied the exposure in 1947. Development during this field was inhibited throughout the 1950's lightweight as a result of the sunshine sources weren't coherent. In 1960, the invention of the optical maser overcame the non-coherent lightweight drawback. Coherent lightweight is lightweight that's monochromatic and of one wavelength. In 1962 Emmett actress and Juries complete that optics may be used as a 3D visual medium. From their work, they used a optical maser to make the primary exposure in history, that of a toy train and bird. Optics is ready to record the part {of light weight of sunshine} waves from AN object by intrusive 2 light waves out of part. The human eye cannot confirm part, however it will notice the part distinction between these 2 beams of sunshine. the initial object is reproduced with a reconstruction beam used on the exposure, making AN apparently 3D image. This image is absolutely simply targeted

lightweight. It's a complicated kind of photography that permits a picture to be recorded in 3 dimensions. optics could be a Lens less Photography. optics captures each intensity level and part. this system can even be accustomed optically store, method info. It involves the utilization of a optical maser, interference, optical phenomenon, intensity level recording and appropriate illumination of the recording. The image changes because the position and orientation of the viewing system changes in mere a similar means as if the article were still gift, so creating the image seem dimensional. The holographic recording itself isn't AN image; it consists of AN apparently random structure of varied intensity, density or profile. The coherent lightweight from the optical maser is split to make AN object beam and a reference beam. the sunshine from the lighted object and therefore the reference beam kind AN interference pattern on the film. This pattern (hologram) contains the data concerning the article which may then be viewed as a 3 dimensional image. Holograms can even be accustomed store, retrieve, and method info optically. In optics there's a light-weight supply is needed that is coherent in nature. coherent mean single wavelength and one rootage and it's additionally monochromatic in nature.

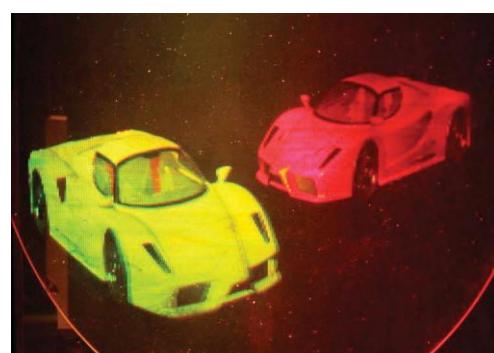


Fig.1: Pictures of colored holograms of two model cars

Holography vs. photography

Holography could also be higher understood via AN examination of its variations from standard photography:

- A photograph represents a recording of knowledge concerning the sunshine that came from the initial scene as scattered in an exceedingly vary of directions instead of from only 1 direction, as in an exceedingly photograph. this enables the scene to be viewed from a spread of various angles, as if it were still gift.

- A photograph will be recorded victimization traditional lightweight sources (sunlight or electrical lighting) whereas a optical device is needed to record a photograph.
- A lens is needed in photography to record the image, whereas in optics, the sunshine from the thing is scattered directly onto the recording medium.
- A holographic recording needs a second beam (the reference beam) to be directed onto the recording medium.
- A photograph will be viewed in an exceedingly big selection of lighting conditions, whereas holograms will solely be viewed with terribly specific sorts of illumination.
- A photograph could be a two-dimensional illustration which will solely reproduce a rudimentary three-dimensional impact.



Fig.2: (a) Photography image of guitar
(b) Holography image of guitar

II. HOLOGRAPHIC DATA STORAGE

Holographic knowledge storage may be a technique which will store info at high density within crystals or photopolymers. The decreasing price of storing knowledge and also the increasing storage capacities of ever smaller devices have created large amounts of knowledge and transmission on the market and simply accessible in each corner of the planet. Holographic knowledge storage may be a potential technology within the space of high-capacity knowledge storage presently dominated by magnetic and traditional optical knowledge storage. Magnetic and optical knowledge storage devices believe individual bits being hold on as distinct magnetic or optical changes on the surface of the recording medium. Holographic storage may be a mass storage technology that uses three-dimensional holographic pictures to modify a lot of info to be hold on in a very a lot of smaller area. The technology uses holograms that area unit created once a light-weight from one beam is split into 2 beams; the signal beam (which carries the data) and also the reference beam. In holographic storage, at the purpose wherever the reference beam and also the knowledge carrying signal beam run across, the photograph is recorded within the lightweight sensitive data-storage medium. once you produce a variance within the reference beam angle or media position then many distinctive holograms is recorded within the same volume of fabric. To browse the hold on holographic knowledge, the reference beam is deflected off the photograph reconstructing the hold on info. This photograph is then projected onto a detector that reads the whole knowledge page of over one thousand thousand bits promptly. Holographic

knowledge storage records info throughout the quantity of the medium and is capable of recording multiple pictures within the same space utilizing lightweight at completely different angles. To date, enhancements in typical technologies like magnetic magnetic disk drives, optical disks and semiconductor reminiscences are able to keep up with the incessant demand for larger and quicker storage. the flexibility to store giant amounts of knowledge in some quite media is of nice importance, as several electronic product incorporate storage devices. As current storage techniques like Blu-ray Disc reach the limit of potential knowledge density (due to the diffraction-limited size of the writing beams), holographic storage has the potential to become consecutive generation of widespread storage media. The advantage of this kind of information storage is that the quantity of the recording media is employed rather than simply the surface. presently on the market SLMs will manufacture concerning a thousand completely different pictures a second at 1024×1024-bit resolution. With the correct style of media (probably polymers instead of one thing like LiNbO₃), this might end in concerning one-gigabit-per-second writing speed. browse speeds will surpass this, and consultants believe one-terabit-per-second readout is feasible. In 2005, firms like Outware and Maxell made a 120 millimeter disc that uses a holographic layer to store knowledge to a possible three.9 TB, that they arrange to market underneath the name Holographic Versatile Disc. Another company, In section Technologies, is developing a competitive format. whereas several holographic knowledge storage models have used "page-based" storage, wherever every recorded photograph holds an oversized quantity of information, newer analysis into mistreatment submicrometre-sized "micro holograms" has resulted in many potential 3D optical knowledge storage solutions. Whereas this approach to knowledge storage cannot attain the high knowledge rates of page-based storage, the tolerances, technological hurdles, and value of manufacturing a poster product area unit considerably lower.

III. HOW HOLOGRAPHIC DATA STORAGE WORKS

In holographic storage, light-weight from a coherent optical maser supply is split into 2 beams, signal (data-carrying) and reference beams. These 2 beams square measure spatially overlapped through the degree of a sensitive medium manufacturing associate optical interference pattern that's imaged inside the medium. This method records data contained within the section and amplitude of the 2 beams. The optical interference pattern generally induces modulations within the index of refraction of the recording material yielding diffractive volume gratings. The reference beam is employed throughout readout to separate off of the recorded grating and reconstruct the knowledge that was contained within the signal beam. The readout of knowledge depends sensitively upon the characteristics of the reference beam. By variable the reference beam, for instance by dynamic its angle of incidence or wavelength, completely different holograms will be recorded within the same volume of fabric and skim out by applying a reference beam similar to that used throughout writing. the quantity of holograms which will be overlapped or multiplexed inside a volume generally depends on the thickness of the fabric the thicker the fabric, the upper

the property of the fabric and so the larger the quantity of holograms which will be multiplexed. data to be hold on is digitized with acceptable error correction and channel modulation. The digital knowledge square measure organized into pages or massive arrays of bits. The 0's and 1's of the information pages square measure translated into pixels of a abstraction light-weight modulator that either block or transmit light-weight. the sunshine of the signal beam traversing through the modulator is thus encoded with the "checkerboard" pattern of the information page. every of the pages of knowledge is recorded because the signal and reference beams interfere through the degree of the storage material. once the suitable reference beam diffracts off of hold on volume gratings inside the fabric, it recreates the array of bits that is projected onto a pixelated detector that reads the information in parallel. The recovered knowledge pages square measure then processed exploitation the channel and error correction codes to reconstruct the first data. during this we tend to to use straight light-weight modulator (SLM) that convert the binary knowledge into black and white pixies. For output device we tend to to most well-liked charge coupled device (CCD).in knowledge storage there's additionally 2 beam the primary one is reference beam and therefore the other is object beam .in .this the reference beam is larged as compare to object beam. And each beam have individual lens and mirror .and each square measure created the interference pattern therefore film is developed .this film is named holographic film.

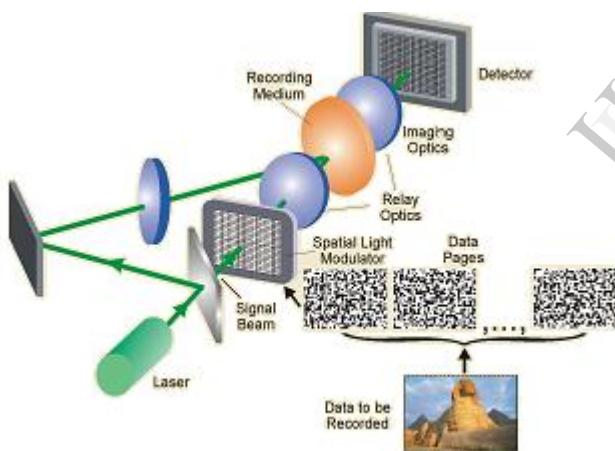


Fig.3:Holographic data storage

V. APPLICATION OF HOLOGRAPHY DATA STORAGE

There square measure several applications that is employed to extend the information storage capability.

(a) Holographic Versatile Disk (HVD): it's a lot of economical then compare to traditional optical disk. Potential to replacement technology in current domains of magnetic and optical storage technology. Resembles Optical Discs just like CD or optical disk a lot of high knowledge density then current optical disk technology will scan and write knowledge in parallel permitting a lot of higher knowledge transfer speeds.



Fig.4: Holographic Versatile Disk (HVD)

(b) Holographic Versatile Card (HVC): Holographic Versatile card (HVC) is Developed by Optware.In HVC there's Lack of moving elements once contend creates. it's the advantage over discs. The HVC speed is a lot of higher then compare to traditional card.

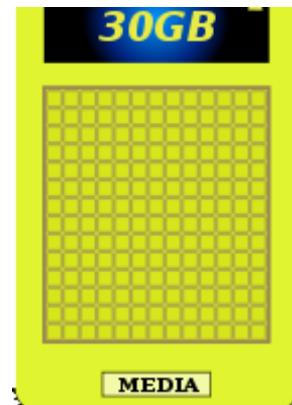


Fig.5: Holographic Versatile Card

(c)Holographic Memory: it's Phenomena of storing data in a very sensitive crystal material exploitation the interference of optical maser light-weight. The 3 options of holographic memory that build it a sexy candidate to interchange magnetic storage medium devices square measure redundancy of keep knowledge, similarity, and multiplexing. Holographic memory uses a light-sensitive material to record interference patterns of a reference beam and a sign beam of coherent light-weight, wherever the signal beam is mirrored off of associate degree object or it contains knowledge within the type of light-weight and dark areas. the character of the light-sensitive material is specified the recorded interference pattern is reproduced by applying a beam of sunshine to the fabric that's a dead ringer for the reference beam.

(d)Computer Generated Hologram: A zone plate will simply be drawn employing a appropriate trojan horse. The output signal, ideally created with a electrostatic printer, is reduced in size and reconstructed; that leads to one purpose. however way more complicated holograms is synthesized yet. Their reconstructions turn out amazingly lovely, three-dimensional pictures of objects, which, strangely enough, haven't existed within the 1st place.

(e) 3D Storage: A exposure could be a recording of associate degree interference pattern created by the interaction of 2 beams of sunshine. completely different image looking on the viewing angle. exploitation the quantity of the medium as hostile solely its surface.



Fig.6: 3D Storage

(f) Holographic Microfiche: it is used for high density information storage is more attractive than conventional microfiche. It can be duplicated more economically and, like laser discs, is impervious to scratches and dirt. It also contains 50 times more information than microfiche.

(g) Holostore: it is a holographic computer memory system being manufactured to replace your disc drive. It will have thousands time more memory capacity and no mechanical movements.

VI REASONS FOR DEVELOPING HOLOGRAPHIC DATA STORAGE

We refer holograph information storage as a result of it's give many functions. It replacement as a backup media and better information density than tape and current arduous drives. And conjointly information is stable for AN calculable fifty years while not degrading, it's give quicker scan and write speeds. It's conjointly Replace optical disk. Higher information density than Blue-Ray. The information storage is quicker scan and writes speeds. Higher ceiling for scoop information storage capability. Conjointly Increasing resolutions for TVs would require additional storage for movies and games.

VII BENEFITS OF HOLOGRAPHIC DATA STORAGE

There is data storage of >1TB/cubic centimeter. Holographic data storage is Current technology can store approximately 4TB on a DVD sized disc. it is also provide Data longevity And Data security. in data storage WORM (Write-once read-many) prevents data from being overwritten. It is also provide Faster Read/Write speeds. Data can be read and written in parallel instead of linearly. Higher speeds are necessary as storage amounts increase. It is also provide larger space for data storage.

VIII DRAWBACKS OF HOLOGRAPHIC DATA STORAGE

Holographic information storage isn't a secure market leader.

If another technology becomes the business normal then read/write instrumentation are exhausting to search out. it's needed pricey development and conjointly needed Existing technology is turning into higher and cheaper. It's troublesome to promote a product that's costlier per GB of storage.

XI CONCLUSION

In conclusion, Holographic Storage has the advantage over Other storage mediums .it is give larger Storage capability, Transfer Rate and Backup. Its main disadvantage is its value of possession. Once Blue-ray was introduced in 2006, a 25-GB disc value nearly \$1 a GB. It's regarding [*fr1] the price currently. Overtime, the general value of holographic information storage ought to decrease to a suitable quantity. Considering all positive and negative aspects, it's currently nearly bound that the

Holographic storage technologies are going to be the winner among the competitive ones. This may be the gap of a brand new space in information storage and processing. Applications requiring and victimization remarkably high storage capacities can revolutionize content distribution, mobile computing and international info security. Prospects embody a lot of economical querying radical dense databases, new varieties of displays, and ultrafast processors engraved into holographic material. However, the technology still desires a number of a lot of years to supply common-place reasonable merchandise.

REFERENCES

- [1] http://www.pctechguide.com/36Storage_Holographic_data_storage.htm.
- [2] http://en.wikipedia.org/wiki/Holographic_data_storage
- [3] <http://www.uflexholography.com/>
- [4] D. Psaltis and G.W. Burr. Holographic data storage. *IEEE Computer*, 31(2):52–60, 1998.]
- [5] R. M. Shelby, J. A. Hoffnagle, G. W. Burr, C. M. Jefferson, M.-P. Bernal, H. Coufal, R. K. Grygier, H. Guenther G. T. Sincerbox. Pixel-matched holographic data storage with megabit pages. *Optics Letters*, 22(19):1509–1511, 1997.ss
- [6] R. M. Shelby, D. A. Waldman, and R. T. Ingwall. Distortions in pixel-matched holographic data storage due to lateral dimensional change of photopolymer storage media. *Optics Letters*, 25(10):713–715, 2000.
- [7] <http://www.holo.com/ho/bo/bo001.html>.
- [8] H. J. Coufal, D. Psaltis, and G. Sincerbox, editors. *Holographic Data Storage*. Springer-Verlag, 2000.
- [9] P. J. van Heerden. Theory of optical information storage in solids. *Applied Optics*, 2(4):393–401.
- [10] G.W. Burr. Volume holographic storage using the $90\pm$ geometry. PhD thesis, California Institute of Technology, Pasadena, Calif., 1996.
- [11] R. M. Shelby, J. A. Hoffnagle, G. W. Burr, C. M. Jefferson, M.-P. Bernal, H. Coufal, R. K. Grygier, H. Guenther G. T. Sincerbox. Pixel-matched holographic data storage with megabit pages. *Optics Letters*, 22(19):1509–1511, 1997.
- [12] R. M. Shelby, D. A. Waldman, and R. T. Ingwall. Distortions in pixel matched holographic data storage due to lateral dimensional change of photopolymer storage media. *Optics Letters*, 25(10):713–715, 2000.