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HALOGRAPHIC DATA STORAGE

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ABSTRACT

Data storage device research and development is a race to keep up with the ever-increasing demand for additional capacity, density, and readout rates. Traditional memory technologies, such as magnetic hard disc drives, optical discs, and semiconductor memories, have kept up with the demand for larger, quicker memories. There is, however, compelling evidence that these two-dimensional surface storage systems are approaching their fundamental limits. Data storage in three dimensions is an alternate option for next-generation memory. The concept of holographic storage was first presented in the early 1960s, shortly after lasers were created, as the next generation of optical storage. Throughout the early 2000s, academic and industry research teams continued to make headway in showing the technology's promise. Although no one has yet developed a mass-market for this technology, numerous companies, such as IBM and Lucent, as well as organisations like the Defense Advanced Research Projects Agency, are developing prototypes. Project Holographic Storage Device (HSD), a cooperation between Microsoft Research Cambridge and Microsoft Azure, reviewed this storage technology in 2020. The project's purpose is to use holographic technology to enable data centre cloud storage. Statista predicts that the amount of global information created in 2020 will be 64.2 zettabytes (ZB), with more than 180 ZB expected by 2025.Enterprises and cloud service providers must find a means to store all of this data in order to keep up with the inevitable demand for storage. One option is holographic storage, which aims to store a large amount of data in a small amount of space while also achieving high performance, availability, and durability requirements.

INTRODUCTION

Holographic data storage is a high-capacity data storage system that creates holographic images of each data instance on a compatible medium to enable data storage. It is based on the same concept as optical storage devices, but it allows vast amounts of data to be stored on a single storage volume.

Three-dimensional data storage is also known as holographic data storage (3D data storage).

To create distinct holographs, holographic data storage technology modifies the light angle, wavelength, and storage media position significantly, allowing hundreds of holographs to fit onto one storage medium. When a data-carrying light beam is split into two beams, one carrying the actual data and the other functioning as a reference beam, it functions.

Before intersecting at the storage medium, both beams are reflected, refracted, and processed through a sequence of operations individually. A three-dimensional (3D) holographic image of the data is formed and stored in the medium at the point of intersection.

The data is extracted by deflecting the reference beam at the same angle onto the storage media. A volumetric storage system is holographic storage, also known as holostorage, three-dimensional (3D) storage, or a holographic data storage system (HDSS). Whereas CDs, DVDs, and hard discs only store data on the surface, holographic data storage uses the entire recording medium to create a holographic image of the data.

Although the functionality of HDSS prototypes varies, most holographic data storage systems are built on the same concept. A blue-green laser, beam splitters, mirrors, LCD panels, lenses, a crystal, and a camera are all basic holographic storage components.

The reference beam emerges from the beam splitter's side and travels a different path to the crystal. When the two beams collide, a pattern is formed on the crystal, which retains data in the crystal's volume. Different sections of the crystal can be used to store data.

The fact that data is recorded in three dimensions distinguishes holographic storage from standard CD/DVD storage. A single laser beam is used in traditional optical media to write data in two dimensions along a continuous spiral data route. Prototype holographic storage devices, on the other hand, save one million pixels at a time in discrete snapshots, sometimes known as pages, that form minuscule cones across the thickness of light-sensitive medium. On a single disc, today's holographic medium can store approximately 4.4 million distinct pages.

RECORDING MATERIALS

Properties of foremost importance for holographic storage media can be broadly characterized as “optical quality,” “recording properties,” and “stability.” These directly affect the data density and capacity that can be achieved, the data rates for input and output

Because holography is a volume storage method, the capacity of a holographic storage system tends to increase as the thickness of the medium increases, since greater thickness implies the ability to store more independent diffraction gratings with higher selectivity in reading out individual data pages without crosstalk from other pages stored in the same volume. For the storage densities necessary to make holography a competitive storage technology, a media thickness of at least a few millimeters is highly desirable.

Holographic recording properties are characterized in terms of sensitivity and dynamic range. Sensitivity refers to the extent of refractive index modulation produced per unit exposure (energy per unit area).

OUTLOOK

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 proportional to one over the third power of the wavelength.

holographic data storage has shown the capability of rapid parallel search through the stored data via associative retrieval.

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.

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 real-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.

FUTURE SCOPE

On paper, holographic storage appears to be quite remarkable. While the word conjures up images of Princess Leia exclaiming, "Help me, Obi Wan Kanobi!" in Star Wars, all you get in reality is a disc. However, it will be intriguing to see if holographic storage can deliver on its promises of longer life, more durable storage, and faster access times. It will also be fascinating to see how quickly the storage sector and the general public embrace this new technology, as this will determine how quickly performance and capacity increases are implemented.

According to Computer Weekly, hybrid holographic storage media may be introduced to remedy the current lack of re-writability. Meaning, the new holographic media might include Flash memory, allowing users to modify data on it. There are a few other issues that we'd want to see resolved. Holographic storage, for example, should be able to transfer data at a rate of one gigabit per second on paper. But that isn't possible right now since it would necessitate the employment of better lasers and better medium material. Because manufacturers are working with the materials and lasers that are currently available, holographic data storage is not realising its full potential speed.

CONCLUSION

Holographic data is a new technology that has yet to be adopted by the public, private, and government sectors. It's only being developed by research labs, namely InPhase Technologies, a Bell Labs company that was tasked with developing a commercially viable version of holographic data storage.

We are enthusiastic, however, about the rapid development and application of holographic data storage technologies. GE has picked up where InPhase Technologies left off, taking tangible measures to establish public-access holographic data storage. Nintendo has also hinted that holographic data storage could be included in their next entertainment system.

Holographic data storage will be advantageous to the environment because it will require fewer discs to store data for institutions, resulting in less waste. Unlike magnetic discs, the material used to store holographic data is easier to dispose of and less hazardous to the environment. Because of the increased archiving capacity, there will be fewer materials to dispose of.

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