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HOLOGRAPHIC TECHNOLOGY

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We use the term information technology or IT to refer to an entire industry. In actuality, information technology is the use of computers and software to manage information. In some companies, this is referred to as Management Information Services (or MIS) or simply as Information Services (or IS). The information technology department of a large company would be responsible for storing information, protecting information, processing the information, transmitting the information as necessary, and later retrieving information as necessary.

In the 1960s and 1970s, the term information technology (IT) was a little known phrase that was used by those who worked in places like banks and hospitals to describe the processes they used to store information. With the paradigm shift to computing technology and "paperless" workplaces, information technology has come to be a household phrase. It defines an industry that uses computers, networking, software programming, and other equipment and processes to store, process, retrieve, transmit, and protect information.

By the early 21st century, nearly every child in the Western world, and many in other parts of the world, knew how to use a personal computer. Businesses' information technology departments have gone from using storage tapes created by a single computer operator to interconnected networks of employee workstations that store information in a server farm, often somewhere away from the main business site. Communication has advanced, from physical postal mail, to telephone fax transmissions, to nearly instantaneous digital communication through electronic mail.

What was once a thing of science fiction has become an integral part of who we are and what we do.Thanks to holographic projection technology, the future is now and fiction is fact. A hologram is a physical structure that diffracts light into an image. The term ‘hologram’ can refer to both the encoded material and the resulting image.

Holographic image can be seen by looking into an illuminated holographic print or by shining a laser through a hologram and projecting the image onto a screen. True three dimensional visualisation technologies have been fantasied and theorised about over the past half century. Unfortunately, holography has not lived up to expectations, which were largely driven by science-fiction fantasy following the iconic Star Wars film in 1977. Conventional 3D is based on glasses or ‘glasses-free’ stereo have a poor 3D experience because it is really just an illusion created by twin-2D images aimed at either eye. This is fundamentally unacceptable to the brain and leads to problems including dizziness and nausea. A true 3D display should have the scene or object in real space (floating in mid-air).

Howdoesholographywork?

Holography is based on the principle of interference. A hologram captures the interference pattern between two or more beams of coherent light (i.e. laser light). One beam is shone directly on the recording medium and acts as a reference to the light scattered from the illuminated scene. It is commonly associated with images being made from light, such as on driver’s licenses or paper currency. However, thisisonly a narrowfieldofholography.

The hologram captures light as it interests the whole area of the film, hence being described as a ‘window with memory’. By contrast a photograph captures a single small area ‘aperture’ of perspective, the photographic image being created by focusing this light onto film or a digital sensor.

The physical medium of holographic film is photo-sensitive with a fine grain structure. Common materials used are silver-halide emulsions, dichromate gelatins and photopolymers – each having their own characteristics and require different processing. Holograms can also be embossed 'stamped into a foil' with applications including in security identification, such as on passports, credit cards, tickets and packaging, as they are difficult to copy without the master hologram.

The hologram is the recorded interference pattern of constructive (intensity peaks) and destructive (elimination) of the superimposed light-wavefronts (the electro-magnetic field). By using a coherent laser light-source and a stable geometry (or short 'pulse' duration) the interference pattern is stationary and can be recorded into the hologram's photosensitive emulsion. The hologram is then chemically processed so that the emulsion has a modulated density, freezing the interference pattern into 'fringes'.

The two basic geometries for holograms are – transmission – where light is shone through the hologram, and – reflection – in which the hologram reflects light. The recording of transmission and reflection holograms were developed from two different fields of enquiry and have distinct optical aesthetics.

The reflection hologram was developed by Yuri Denisyuk (1927–2006) who used a single beam to both illuminate the object and be the reference. Denisyuk's process follows the colour and spatial photographic recording practices of Lippmann photography and Daguerreotypes, which were created on polished metal surfaces. Gabriel Lippmann (1845–1921) claimed to have invented a method of colour photographic recording and provided a scientific explanation of how the emulsion structure recorded and then could reconstruct optical standing waves patterns, the particular wavelengths of which comprise a colour image.

Ways of development of holographic technology

1. Using Holograms to Improve Electronic Devices

We compare the geometrical limits of the recording density that can be attained in three-dimensional optical memory systems that employ the multilayered bit-recording method and the angularly multiplexed holographic recording method. Both recording methods have the potential to overcome the recording density limitations in current optical storage systems. Using the Ewald sphere construction, we analyze the lateral and longitudinal bandwidths for each recording method. The respective recording densities of the two methods are also derived directly in the space domain and compared with each other. With the bit-recording method, we found that the memory density increases inversely with the f-number of the recording lens. On the other hand, the density that can be achieved using holographic recording first increases with theft-number values, attains a maximum, and then decreases at larger f-number values. This implies that the bit-recording method yields larger memory densities when lenses of smaller f-numbers are used in the optical system.

Researchers have demonstrated a holographic memory device that could improve storage capacity and processing capabilities in electronics.

Riverside, California — a team of researchers from the University of California, Riverside Bourns College of Engineering and Russian Academy of Science has demonstrated a new type of holographic memory device that could provide unprecedented data storage capacity and data processing capabilities in electronic devices.

The new type of memory device uses spin waves – a collective oscillation of spins in magnetic materials – instead of the optical beams. Spin waves are advantageous because spin wave devices are compatible with the conventional electronic devices and may operate at a much shorter wavelength than optical devices, allowing for smaller electronic devices that have greater storage capacity.

Experimental results obtained by the team show it is feasible to apply holographic techniques developed in optics to magnetic structures to create a magnonic holographic mem-

ory device. The research combines the advantages of the magnetic data storage with the wave-based information transfer.

"The results open a new field of research, which may have tremendous impact on the development of new logic and memory devices," said Alexander Khitun, the lead researcher, who is a research professor at UC Riverside.

The first holograms were designed in the last 1940s for use with electron microscopes. A decade later, with the advent of the laser, optical holographic images were popularized. Since, other fields have significantly advanced by using wave interference to produce holograms, including acoustic holograms used in seismic applications and microwave holography used in radar systems.

Holography has been also recognized as a future data storing technology with unprecedented data storage capacity and ability to write and read a large number of data in a parallel manner.

Khitun has been working for more than nine years to develop logic device exploiting spin waves. Most of his initial research was focused on the development of spin wave-based logic circuits similar to the ones currently used in the computers.

A critical moment occurred last year when he decided the device did not need to replace the computer's electronic circuits. Instead, the device would complement the circuits, or help them accomplish certain tasks, such as image recognition, speech recognition and data processing.

The experiments conducted using a 2-bit magnonic holographic memory prototype device. A pair of magnets, which represent the memory elements, were aligned in different positions on the magnetic waveguides.

Spin waves propagating through the waveguides are affected by the magnetic field produced by the magnets. When spin waves interference was applied in the experiments, a clear picture was produced and the researchers could recognize the magnetic states of the magnets. All experiments were done at room temperature.

2. Security hologram

Security holograms are very difficult to forge because they are replicated from a master hologram which requires expensive, specialized and technologically advanced equipment. They are used widely in several banknotes around the world, in particular those that are of high denominations. They are also used in passports, credit and bank cards as well as quality products. Herman Lopata, the President of the New York based Automatic Toll Systems, Inc., received a patent in 1987 for the credit card security hologram as part of his early work on high speed highway toll collection—the predecessor of the modern EZ Pass type equipment.

3. 3D HologramstoSmartphones.

Smartphones could soon project holographic images, thanks to technology showcased by MasterImage 3D at the Mobile World Congress.

The Hollywood, California -based company is developing a projection system that would allow smartphones to display 3-D holograms. MasterImage, a leading developer of 3-D display systems for movie projectors, said the holographic projection can be used as an interface to control smartphones and tablet PCs. The holographic interface can be used to control text, surfing, taking pictures or any other function on a mobile device.

4. Dot-matrixholograms

Dot-matrix hologram printing is a technique of building up an image of diffractive 'pixels'. Each area is recorded with a particular geometry that diffracts light by a corresponding angle. The illuminating light is deflected into varying divergent colour-spectrums. The image is a tiling of colours which means the images are very bright but do not have 3-d depth information. Dot-matrix holograms have been used as a means of decorative 'light architecture'. Michael Bleyenberg defines 'light architecture': "This term indicates a vision: to 'plan

and construct' environments beyond everyday perception and experience, barely tangible, not using solid material, but the ephemeral medium light."

5. Other applications

- Holographic optical elements (HOE's) are used for navigation by airplane pilots. A holographic image of the cockpit instruments appears to float in front of the windshield. This allows the pilot to keep his eyes on the runway or the sky while reading the instruments. This feature is available on some models of automobiles.
- Holograms are used in advertisements and consumer packaging of products to attract potential buyers.
- Hologramshavebeenusedoncoversofmagazinepublications. OneofthemostmemorableSportsIllustratedcoverswastheDecember 23, 1992 issuefeaturingMichaelJordan. Hologramshavealsobeenusedonsportstradingcards.
- Theuseofhologramsoncreditcardsanddebitcardsprovideaddedsecuritytominimizecounterfeiting.
- Holographyhasbeenusedtomakearchivalrecordingsofvaluableand/orfragilemuseum artifacts.
- SonyElectronicsusesholographictechnologyintheirdigitalcameras. A holographic-crystalisusedtoallowthecameratodetecttheedgeofthesubjectanddifferentiatebetweenitandthebackground. As a result, thecameraisabletofocusaccurately indarkconditions.
- Holography has been used by artists to create pulsed holographic portraits as well as other works of art.

6. Future applications of holography

1. Future colour liquid crystal displays (LCD's) will be brighter and whiter as a result of holographic technology. Scientists at Polaroid Corp. have developed a holographicreflector that will reflect ambient light to produce a whiter background.
2. Holographicnightvisiongoggles.
3. Many researchers believe that holographic televisions will become available within 10 years at a cost of approximately $5000. Holographic motion picture technology has been previously attempted and was successful in the 1970s. The future of holographic motion pictures may become a reality within the next few years.
4. Optical computers will be capable of delivering trillions of bits of information faster than the latest computers.

Conclusion

Holography allows for the recording and reconstruction of spatially-dependent images. Theholographicimageisbasedonoptical-materialinterferenceratherthansensorsandprograms; theinformationisenfoldedwithinthesurfaceratherthanbeingappliedontoit. Wesensethedifferencebymovingaround, andreturningtofindtheimageagain. Theholographicimagehasitsownpresence, whichwemovethrough, playingtheimagewithourownperceptionandagency.

The high storage densities, rapid read rates, high fidelity data recovery, high fidelity imaging of data pages, low levels of noise in data recovery and long life create many new and exciting application areas for remote holographic technology. Thespreadofhologramtechnologywillsoonreducethevalueofordinaryembossedhologramsasanti-counterfeitdevices. Onotherhand, advancesweforeseeinrecordingmaterials, hologramrecordingsystemsandembossingsubstratematerialsshouldgreatlyincreasethesecurityvalueofhologramswithinthreeorfouryears. Thismakeholographypoisedtobecome a compellingchoicefornext-generationstorageandcontentdistributionneeds. In addition, the flexibility of the technology allows for the development of a wide variety of holographic storage products that range from handheld devices for consumers to storage products for the enterprise.