Review of Various Data Storage Techniques

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Abstract: *The data storage is one of the basic requirements of today's technical world. Improved and new multimedia applications are demanding for more and more storage space. Hence to meet this requirement day by day new techniques are coming in to the picture. This paper summarizes the various techniques used for the storage of data, their characteristics & applications with their comparative analysis.*

Keywords: Memory, semiconductor storage, magnetic storage, optical storage.

1. Introduction

Storing of data is very important and basic requirement of today's life. All the applications we are using require the storage of many programs and day by day the applications are improving and the memory requirement is increasing and to meet the current storage requirement we are reached to holography and 3D optical storing techniques, as for various multimedia applications the storage need is increasing day by day.

This paper is organized as Section II describes the magnetic storage, its different types, advantages and disadvantages, Section III describes the semiconductor storage, its different types, advantages and disadvantages, Section IV describes the optical storage, its different types, advantages and disadvantages, Section V describes the comparative analysis of magnetic, semiconductor and optical memory, Section VI presents the conclusion.

2. Magnetic storage

Magnetic disk storage is used in mechanical hard drives to keep track of permanent information. On the other hand, the main memory is used by RAM chips to store the data temporarily that the computer needs to calculate and track the programs it runs [1].

Advantages of magnetic memory:

• Persistence: The biggest advantage of magnetic disk storage over main memory is persistence of data. The RAM chips that house our main memory contain large numbers of tiny electric switches, each stores a bit of information. When the power goes off, all of that information disappears forever. Drive, on the other hand, has a magnetic platter covered with tiny zones of charged magnetic fields. Those magnetic fields stay there, storing our information even when we aren't actively using our computer.
• Capacity: One of the greatest things about magnetic disk storage is that it needs a very small amount of space to fit a tremendous amount of information. Size of the hard drives stay the same size but now are able to fit more and more information onto the magnetic platters. The High-end hard-drive storage is measured in terabytes i.e. thousands of gigabytes of information**.**

• Cost: Since the beginning of computing, hard drives have come down in price, and they continue to do so. Big advantage of main memory is that has become a lot cheaper, but its storage limitation is still a big factor. A RAM stick often holds less than 1 percent of the data capacity of a hard drive with the same price.

Various types of magnetic memories are:

2.1 Magnetic tape

Today, except in some of the cases where we require legacy compatibility, magnetic tape is generally used in cartridges for computers. As magnetic tape was originally designed for the purpose of sound recording, and the recorded information is assumed to be accessed in a sequential manner because as we know that the random access requires rewinding the tape and results in unbearably long wait time, so we assume sequential access here [2].

Advantages of magnetic tape are:

a) Low cost (per Mbyte) and
b) This technology is of choice for many applications where access times have not been an issue because it provides high data reliability [3].

2.2 Magnetic disk

Magnetic disks were commercialized in the 1950s and it enabled random accesses process with shorter wait time. Magnetic discs eventually came to replace the magnetic tapes for the secondary information storage. Those days magnetic tape still possesses significant advantages in cost-capacity ratios, so, market also did not move away from tape as it was used for tertiary information storage. Magnetic disks have achieved areal density improvements which results in the reduction of cost per capacity [4].

2.3 Magnetic Twistor Memory

An attractive solution to the problem of high capacity semi permanent storage at low cost is presented by the permanent magnet, twistor memory [5]. Twistor stores the patterns in magnetic tape instead of the circular magnets.[6] In this random access is provided to any address and nondestructive read-out of information. However, cycle times of memories have been limited to several microseconds [7].

2.4 Magnetic Bubble memory

With the recent spread of microcomputer the demand for low cost, compact, nonvolatile solid-state storage with high reliability has been increased. Magnetic bubble memories are enough capable so that it can meet these requirements, because they offer low cost, low power consumption, high density, no volatility and high reliability [8]. Magnetic bubble memories have found applications in the fields of electronic switching, announcing, data transmission and computerized numerical control [9]. They can be used for many other applications in microcomputer if they are easy to use and can prove there self perfect non volatile. Magnetic bubble memory is one of the magnetic recording technologies and it has all solid state with all above mentioned features memory and it is also a maintenance-free operation [10]. Having all these desirable features the applications of this memory is expanding. It is used in electronic switching systems, POS (Point of Sales), process controllers, etc because it is high reliable and maintenance free [11]. As it is highly durable in harsh environments therefore it is used in numerical control machines, factory automation, space, avionics etc..

3. Semiconductor Storage

The semiconductor memories evolution has take place rapidly may be because of following factors:

a) The rapid technical advances made in semiconductor wafer processing, and
b) Associated advances in the economics of device packaging.

Advantages of semiconductor memories:
a) Low production cost
b) Low power consumption
c) Greater capacity that can be produced from small I'Cs (integrated circuits) [12].

3.1 Read only memories

The following description covers all memories in which a fixed data pattern is stored and which is unalterable. At the time of manufacturing, this data pattern is built into the device. ROMs are used principally where a fixed memory program is required, e.g. logic function generators, coders, pattern generators etc. Many types of read only memories are explained below:

1. Programmable read only memory (PROM)
In this during the manufacturing process or after it is manufactured the data content of each storage cell can be altered only a single time only. In this, the pattern is inserted after the memory is manufactured by a fusible link program which carried out by the user itself.
2. Erasable Programmable read only memory (EPROM)
In this type of ROM the memory is exposed to a suitable radiation source so that the data in its storage cells can be erased (when required) and after that the memory can be reprogrammed so that it can store a different or new data pattern.
3. Electrically alterable read only memory(EAROM)

In this type of ROM the data content of all cells can be returned to a desired state if a suitable electrical voltage is applied to the control gate of a double gate. The EPROM or EAROM type of memory is widely used in such applications where an equipment program required periodic updating.

3.2 Read/Write memories and random access memories

A read/write memory is one in which by applying suitable electrical signal to the control and address inputs of the memory we can select any memory cell to sense at any terminal (to read the stored data) or change the data in each memory cell. Hence we can say that, the operation sequence's task is to write the required data pattern into the memory or into one of the memory cell and it also can be read out subsequently, and finally it should be able to alter the data pattern by writing in new data when it is required(for some new application). A 'random access' memory may be defined as a memory which permits the user to access any of its address locations in any desired sequence. Hence we can say that a RAM may be either a read/write memory or a read-only memory.

3.3 'Static' and 'dynamic' read/write memories

A 'static' read/write memory is one in which the data content is retained as it is even in the absence of control signals but its power supply must remains energized. A 'dynamic' read/write memory is one in which the applications of control signals is required periodically in order to retain the stored data and it is known as refresh operation. The dynamic arrangement is quite common but on the other hand the static arrangement is very uncommon. Read/write memories are used in the largest number of applications and represent the largest range of memory devices which are available. They are required in any information processing system in which it is necessary to store the digital data temporarily and subsequent retrieval.

3.4 'Non volatile' and 'volatile' memories

The term Non volatile is used to define the capability of the memory to retain the stored data in the absence of power supply. Volatile memory means that it does not retain the stored data when power supply is disconnected. EPROM semiconductor memories are considered to be 'nonvolatile' because in it the data is stored in the form of trapped charge in the silicon structure which is not dependent on the power supply. Rest all other types of semiconductor memory are 'volatile' and the Bubble memories are 'nonvolatile'.

4. Optical storage

The term Optical means that we store the data on an optically readable and writeable material. Data is written on the material by making marks in a pattern that can be read back with the use of light (generally for high accuracy we use laser beam which is focused on a spinning disc) [13]. There are also some other means of optically storing data and some of the new methods are under development. Optical storage is a different form of data storage by other technologies such as magnetic and semiconductor memories. Optical storage has a wide range which varies from a single CD-ROM to multiple drives reading which can read multiple discs such as an optical jukebox. It was estimated in 2007 that the total worlds storing capacity will be represented by optical storage technology will be 27% [14].

Advantages of optical memories are:

1. Optical memories are durable:
Optical media can exist for a long time but it depends on what kind of optical media we are choosing, but proper care is required. These memories are very good for archiving. In many forms of optical media when once data is written to them, that storage device cannot reused for again writing the data but the stored data can be read by the user as many times the user wants. This is known as WORM (WRITE-ONCE READ-MANY). This is an advantage for archiving because if data is written then data will be preserved permanently foe ever without any possibility of being overwritten.

2. Transportability:
Now a day optical media can be used on many platforms such as PC. For example, the data written on a DVD-RAM can easily read on any system (or PC)   which will be having an optical device and also it must be having same file system.

3. Random access:
It means that optical storage devices can pin-point the stored data on the user request without having any effect of that how the data is stored on it or in what sequence the data is stored. It decreases the access time of the memory or we can say that the data will be retrieved faster [15].

Disadvantages of optical memories:

a) Optical memories which are WORM are good for the archiving but it also prevents us from being able to use that particular storage again.
b) To write data on optical media, server compress data so that compressed data can be written on the memory. But this process will take more unit resources and this may increase the time required to write and restore that data [16].

4.1 Optical tape

The main reason for market to accept optical tape so widely is that it is an effective solution for users who are seeking for storage of large data quantities and also highly cost efficient [17]. It is the first choice because it is;

a) Low cost media.
b) Have good accessibility.
c) It is secured and
d) In this memory the prime concerns are permanence of large volumes of valuable data.
Hence we can say that optical tape is very attractive solution to the large volumes of digital data storage. All these desirable Characteristics have been achieved by selecting the materials very carefully and technology is processed at an early stage in development procedure.

Advantages of optical tapes are:

a) Volumetric storage density
b) High Data rate
c) High Data lifetime
d) Cost efficient.

4.2 Optical Jukebox

The physical place that is present in jukebox for storing the optical disks decides the amount of information that can be stored in it. Optical disks are passive devices they do because it does not consume energy and also their expected life time is longer if compared with magnetic disks. One more important thing is for creating backup copies and for information distribution the creation of duplicate disks are easy[18]. But the processing of loading a new file or for the starting of a new application the Optical disks are slower because may be the robot of jukebox needs to unload a disk and then it has to load the desired optical disk into a drive. Content of the optical discs can be accessed directly as on a hard disc when it is loaded and is in rotation. Jukeboxes are used in imaging, medical, and video that is high-capacity archive storage environments.

4.3 Hologram data storage

Holography was invented in 1947 by Hungarian physicist Dennis Gabor (1900-1979), for which he received the Nobel Prize in physics in 1971. Holography is a method of lens less photography in which the wave field of light scattered by an object is recorded on a plate as an interference pattern.

The three features of holographic memory that make it an attractive candidate to replace magnetic storage devices are:

a) Redundancy of stored data

b) Parallelism

c) Multiplexing [19].

4.4   3D optical memory

As we can predict from the name of memory that it is a type of memory (storage technique) in which information can saved or retrieved with 3D resolutions. This new and latest innovation has that much potential as it can provide very high mass storage of petabyte level. Data recording and reading back of data procedures are performed within the medium by focusing the lasers. One of its useful qualities is that it is of volumetric nature. In this technique some kind of nonlinearity is required for the ensurance of prevention of non-interference of other data points with the desired addressed points [20].

No commercial product based on 3D optical data storage has yet arrived on the mass market, although many companies (IBM etc.) are actively developing the technology and they are claiming that it may become available "soon".

5. Comparative analysis of Magnetic, semiconductor and optical storage

COMPARISON	MAGNETIC MEMORY	SEMICONDUCTOR MEMORY	OPTICAL MEMORY
1. Basic Concept	Magnetic storage is used	Data is stored on ICs or	Data is written on the material by making

	in mechanical hard drives to keep track of permanent information.	transistors temporarily or permanently.	marks in a pattern that can be read back with the use of laser light.
2. Type Of Memory	i) Magnetic tape. ii) Magnetic disc. iii) Magnet twistor memory. iv) Magnetic bubble memory.	i) Read only memory. ii) Read/write memories and Random access memories. iii) Static and Dynamic memory. iv) Non- volatile and volatile memory.	i) Optical tapes. ii) Optical Jukebox. iii) Hologram data storage. iv) 3D optical memory.
3. Advantages	i) Persistency. ii) Capacity. iii) Low cost.	i) Low production cost. ii) Low power consumption. iii) Greater capacity can be produced from small ICs.	i) Durability. ii) Transportability. iii) Random access.
4. Disadvantages	i) Large access time. ii) Serial access.	i) Except EPROM all semiconductor memories are volatile. ii) Refresh operation is required in order to retain the stored data.	i) Particular storage can not used to store data again as optical memories are WROM. ii) Time required for writing and restoring the data is more.

6. Conclusion

In this paper we have seen basic features of various memories, their advantages and applications and how further developments are occurred as applications increases and hence storage requirements increases. Today we are moving forward to hologram technique and 3D optical storage to overcome the drawbacks of memories and improving the existing memories to meet the storage requirement of this multimedia world. It will be a big and satisfactory achievement for all capacity hunger multimedia applications and advancements.

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