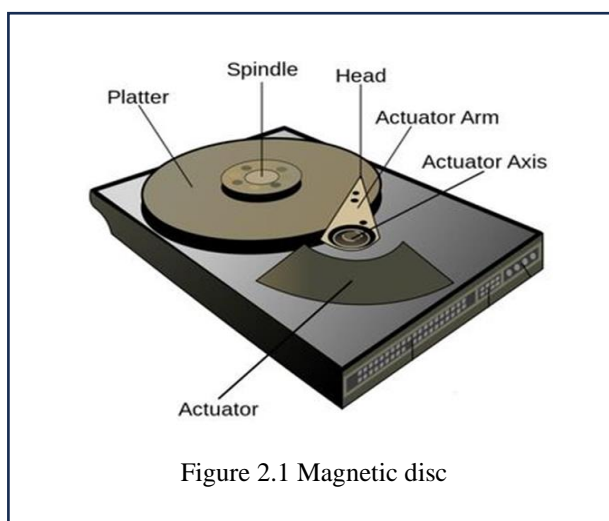


Study of magnetic disc

1. Introduction

Magnetic disks represent another category of non-volatile storage means applied in computers and their associated digital devices to store information. Such disks enable the application of magnetic storage technology that is founded on the notions of magnetic fields being suitable for expressing binary code (zeroes and ones). Hard disk drive (HDD) is the most popular form of magnetic disk, despite there being older forms such as magnetic tape or floppy disc.



2. History

Here's a brief overview of the history of magnetic disks:

Year	Event	Details
1888	Wire Recording	Oberlin Smith publicized the concept of recording audio on a wire.
1898	First Magnetic Recorder	Valdemar Poulsen invented the first magnetic recorder, which recorded on a wire.
1928	Magnetic Tape Recorder	Fritz Pfleumer developed the first magnetic tape recorder.
1953	First Magnetic Tape Drive	IBM introduced the IBM 727, the first magnetic tape drive for data storage.

1956	First Hard Disk Drive	IBM's RAMAC 305, the first hard disk drive, stored 5 MB of data on fifty 24-inch disks.
1962	Magnetic Disk Technology	Magnetic disk technology was applied to data storage, enabling random access to data.
1970s	Floppy Disks	Small, flexible plastic disks called floppy disks were developed.
1980s	Advancements in Hard Drives	Significant improvements in hard drive technology, including increased storage capacity and reduced size.
1990s	Transition to Digital	Magnetic storage devices transitioned from analog to digital data storage.
2000s	Modern Hard Drives	Continued advancements in hard drive technology, leading to the development of portable and high-capacity drives.

3. Available Technologies in the field

The magnetic disk technology has seen numerous innovations and evolutions. Some of the available types are:

I. Hard Disk Drives (HDDs): These are the most commonly used magnetic storage forms. HDDs utilize rotating disks known as platters that have been coated with magnetic materials while data is read or written by a moving magnetic head over this spinning disk. These pieces of equipment come with huge memory sizes at low prices hence making them ideal for personal computers, servers, etc.

II. Magnetic Tapes: More often than not, such devices are utilized during backups or archival processes and consist of a long strip of plastic film that has thin layer of magnetically based substance¹ that allows one to record data sequentially hence being slow when accessing but effectively storing large amounts of information for long-duration time periods.

III. Magneto-Optical Drives (MO): This type uses both magnetic and optical means to read or write pieces of information which ensures high integrity hence they are mostly used for archival purposes.

IV. Floppy Disks: Even if they barely exist nowadays, there was a time when floppy disks were popular among people wishing to store their data magnetically; they have since been rendered outdated by better performing USB drives or cloud systems owing their higher capacity.

V. Phase Change Technology: Data can be stored in a material by changing its state from

amorphous to crystalline type and then vice versa. It is used in some advanced magnetic storage devices.

VI. LIMDOW (Light Intensity Modulated Direct Overwrite): LIMDOW is a technology used in some magneto-optical drives to allow direct overwriting of data without the need of an erase cycle.

4. Working and basic concepts

Magnetic disks store data in the form of tiny magnetic regions, each representing a bit of data. The disk is made of a platter coated with a magnetizable material. When data is written, a write head magnetizes areas of the disk in a specific direction to represent binary 1s and 0s. When reading, the read head senses the magnetic orientation and translates it back into data.

The key components involved include:

- **Platters:** The physical disks that store data.
- **Read/Write Heads:** Responsible for reading and writing data.
- **Spindle:** Rotates the platters.
- **Actuator Arm:** Moves the read/write heads to the correct position over the platters.

5. Study of Varius Parameters (Cost, Speed and Performance)

Cost:

Hard Disk Drives (HDDs): For bulk storage HDDs are more cost-effective compared to solid-state drives (SSDs). They have lower cost per gigabyte hence they are preferred.

Magnetic Tapes: In terms of long-term storage and backups, these have even greater cost-effectiveness than HDDs. Though they have a lower cost per terabyte than an HDD, they are also slower when it comes to data access.

Speed:

HDDs: The speed of HDDs is expressed in revolutions per minute (RPM). The common speeds are 5400 RPM and 7200 RPM; the higher the RPMs the faster the data access. However, they still lag behind SSDs in terms of speed.

Magnetic Tapes: Being sequential access devices, they have slower data access speeds. Consequently, winding the tape to the right place is essential to read a certain piece of information.

Performance:

HDDs: RPM, cache size and data density are some of the factors that affect performance. To this regard, higher RPMs and larger caches tend to improve it as well. For applications that require large storage capacities, but do not necessarily demand fast data access, HDDs are suitable.

Magnetic Tapes: For backup and archival purposes, performance is adequate. Their dependability is very high making them last long; however, their sequential nature makes them inappropriate for frequently accessed applications.

6. Market Study

- **Number of users:**

Those magnetic disks, more specifically hard disk drives (HDDs), happen to be a very common storage medium in a variety of industries:

Consumer Electronics: The millions who own personal computers, laptops or gaming consoles all have an HDD as their main file storage unit.

Data centers: Because of cost, most vast data centers rely heavily on bulk storage from HDDs.

Enterprise storage: HDDs are employed by companies to run servers and also as storage solutions when there is need for large capacity applications.

Back-up and archival: It is in backup and archival purposes that most industries make use of magnetic tapes to great extent.

- **Key Players in the market:**

The magnetic disk industry is chiefly dominated by several top corporations particularly in HDD segment:

Seagate Technology: It is one of the largest producers of HDDs and is well known for its wide range of products that cater to consumer as well as enterprise markets.

Western Digital Corporation: Another major stakeholder, this brand provides different types of HDDs and also SSDs for both personal and business needs.

Toshiba Corporation: This company has an important position in HDD sector providing storage solutions across various purposes.

Hitachi Global Storage Technologies (HGST): Now part of Western Digital, HGST made significant contributions to the development of high-capacity HDDs.

- **Market Segmentation:**

Form Factor: Computers typically use 2.5 inch and 3.5-inch drives; where the first one is appropriate for laptops while the second serve desktops and servers.

Application: Mobile, consumer, desktop, enterprise, and nearline storage.

Geography: Major markets include North America, Europe, and Asia Pacific.

7. Future Advancements in Progress

I. Increased Areal Density

Heat-Assisted Magnetic Recording (HAMR): This specific technique utilizes a laser to warm up the disk substance and that enables writing data in a much denser form. It has been anticipated that this technology will enhance the capacity of hard disk drives by a great margin.

Microwave-Assisted Magnetic Recording (MAMR): MAMR is very similar to HAMR, it uses microwaves as an aid to writing information at greater densities on disks. It also serves to improve HDDs' storage capabilities.

II. Improved energy efficiency

Energy-Assisted Magnetic Recording (EAMR): The idea is to lower the power consumption needed in writing data thus improving hard disk drives (HDD) efficiency.

III. Hybrid Storage solution

Hybrid Hard Disks: They combine HDDs and SSDs forming hybrid disks which have big storage capacity of hard disk drives but the quickness of solid-state disks.

IV. Security Enhancements

Encryption and Data Integrity- The recent progressions in cryptography technology and fault tolerance codes are being employed in magnetic storage devices so as to increase their security against corruption and ensure accurate information retrieval.

8. Conclusions

Magnetic disks have played a crucial role in evolution of data storage technology and remains relevant today. Despite competition from SSDs, HDDs are still the preferred choice for applications requiring large, cost-effective storage. Continuous advancements like SMR and HAMR ensure that magnetic disk technology will remain important in the foreseeable future. However, the rise of flash-based storage devices and cloud solutions is likely to gradually reduce the reliance on traditional magnetic disks.

9. Indian Contributions to the field

India has made several noteworthy contributions to magnetic disk technology, especially through R&D activities. Some major points are:

I. Research and Development: Research on magnetic storage technologies has been significant in Indian institutions such as Indian Institute of Technology (IIT) and Centre for Development of Advanced Computing (C-DAC). These centers have contributed to the evolution of new ways in data storage besides having partnership with global technology firms.

II. Industry Contributions: The Indian IT companies like TCS, Infosys and Wipro have been developing software solutions therefore this leads to improved performance and reliability in magnetic disk storage systems. They have also offered assistance to worldwide customers dealing with vast amounts of data stored.

III. Government Initiatives: The government of India has encouraged academic research in the area of data storage technologies through numerous schemes. For instance, it is MeitY which is financing further development of advanced storage technologies¹.

IV. Academic Contributions: A significant number of publications have been made by Indian researchers on magnetic disk technology that have contributed to global information pool. Most often than not these publications investigate ways of enhancing the storage density, speedily fetching data from disks as well as general performance of magnetic disks².

V. Startups and Innovation: Data storage among the Indian startups is taking shape. Similar way NetApp India and Seagate Technology India are working on new storage solutions that use magnetic disk technology.

India's active involvement in the progress of magnetic disk technology, both through academic research and innovative ideas from the industry, is demonstrated by these contributions. Don't hesitate to let me know if you require further clarification on any point.

10. References

1. "Heat-Assisted Magnetic Recording," IEEE Transactions on Magnetics, 2021.
2. "Magnetic Disks: Evolution and Future," Journal of Computer Storage Technologies, 2022.
3. Seagate Technology Official Website, www.seagate.com.

