

# Unit II

## Computer Hardware

*2.1 Basic Components: Input, Output, Processing, Storage*

*2.2 Types of Computers (Desktops, Laptops, Servers, Mobile Devices)*

*2.3 Hardware Components*

*2.4 Central Processing Unit (CPU)*

*2.5 Memory (RAM, ROM)*

*2.6 Storage Devices (Hard Drives, SSDs, External Storage)*

*2.7 Input and Output Devices (Working principle, application)*

*2.7.1 Keystroke Devices*

*2.7.2 Touch Devices*

*2.7.3 Voice-Controlled Devices*

*2.7.4 Movement-Controlled Devices*

*\* Game Controllers (joysticks, gamepads, and VR controllers.),*

*\* Gesture-Control Devices, Leap Motion for touchless interaction.*

#### 2.7.5 Brain-Computer Interface (BCI):

#### 2.8.6 Wearables:

*\* Smart glasses, AR/VR headsets (e.g., Oculus, HoloLens).*

#### 2.7.7 Haptic Feedback Gloves:

*\* Used in VR and advanced interaction systems.*

#### 2.7.8 Biosensors:

*\* Devices that track physiological data (e.g., heart rate monitors).*

#### 2.7.9 Data Scanning Devices

*\* Barcodes, QR code scanners.*

*\* RFID: Radio Frequency Identification scanners for contactless identification.*

*\* Biometric Scanners: Fingerprint, iris scanners.*

#### 2.7.10 Digitizers:

*\* Graphics tablets, touch-sensitive stylus input.*

#### 2.7.11 Microphones:

*\* Analog, digital, condenser microphones for voice input.*

#### 2.7.12 Electronic Cards Based Devices

*\* Smart cards, debit/credit cards with NFC/RFID technology.*

#### 2.7.13 Speech Recognition Devices

#### 2.7.14 Vision-Based Devices

*\* Cameras, LiDAR, infrared sensors, facial recognition systems.*

### 2.8 Output Devices (Working principle, application)

*\* Monitors: CRT, LED, OLED screens.*

*\* Printers: Inkjet, laser, 3D printers.*

*\* Projectors: DLP, LCD.*

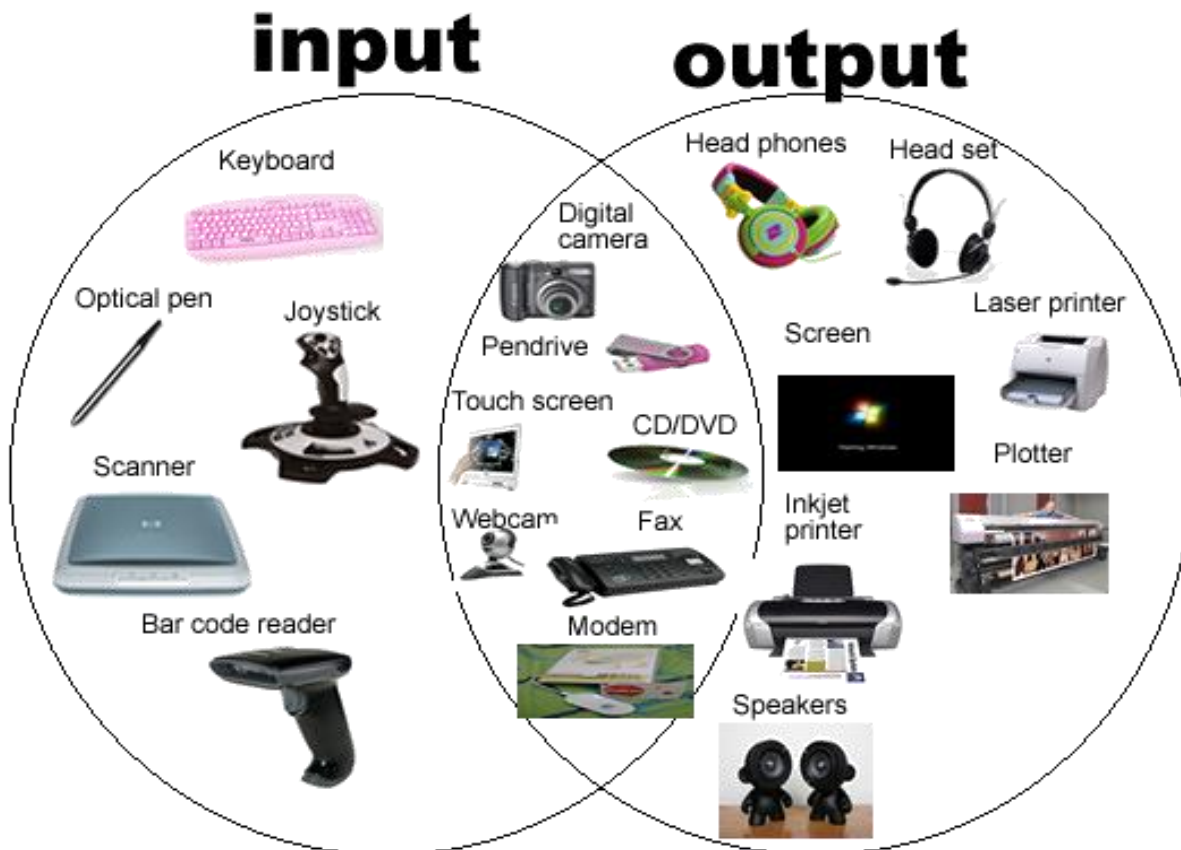
*\* Audio Output: Speakers, headphones, and surround sound systems.*

*\* Tactile Output: Braille readers, haptic feedback systems.*

## 2.1 Basic Components: Input, Output, Processing, Storage

- A computer is a programmable electronic device that accepts raw data as input and processes it with a set of instructions (a program) to produce the result as output.
- It renders output just after performing mathematical and logical operations and can save the output for future use.
- It can process numerical as well as non-numerical calculations. The term "computer" is derived from the Latin word "computare" which means to calculate.

- **Input:** Devices like keyboards, mice, scanners, and sensors that allow users to provide data or instructions to the computer.
- **Output:** Components such as monitors, printers, and speakers that present processed data to the user.
- **Processing:** The Central Processing Unit (CPU), which performs calculations and executes instructions.
- **Storage:** Includes primary memory (RAM and ROM) and secondary storage (HDDs, SSDs) for saving data and instructions.



## 2.2 Types of Computers (Desktops, Laptops, Servers, Mobile Devices)

Computers are categorized based on their size, portability, and purpose. Below is an overview of the common types of computers:

### 1. Desktops:

- Fixed, powerful systems for personal or professional use.
- Stationary computers designed for regular use at a single location. They consist of separate components like the monitor, CPU, keyboard, and mouse.
- **Features:**
  - High performance with upgradable hardware.
  - Larger storage and screen size compared to laptops.
  - Requires a constant power supply.
- **Applications:**
  - Used in offices, schools, and homes for tasks like document editing, gaming, and data analysis.



### 2. Laptops:

- Portable computers with integrated components such as a monitor, keyboard, and battery.
- **Features:**
  - Compact and lightweight, ideal for mobility.
  - Rechargeable battery allows operation without a continuous power supply.
  - Slightly lower performance compared to desktops of the same generation.
- **Applications:**
  - Widely used by students and professionals for online learning, presentations, and work on the go.



### 3. Servers:

- High-capacity computers designed to manage network resources, store data, and provide services to multiple users simultaneously.
- **Features:**
  - Powerful processors, large memory, and storage capacity.
  - Operate 24/7 with advanced cooling systems.



- Can be physical (on-premises) or virtual (cloud-based).
- **Applications:**
  - Hosting websites, managing databases, and running applications for businesses.
  - Centralized file storage and resource sharing in organizations.
- **Examples in Nepal/Asia:**
  - Nepal Telecom uses servers to manage its telecommunications network.
  - Banks in Nepal use servers for secure transaction processing.
  - Cloud servers from companies like Alibaba and AWS are used in Asia for hosting applications.

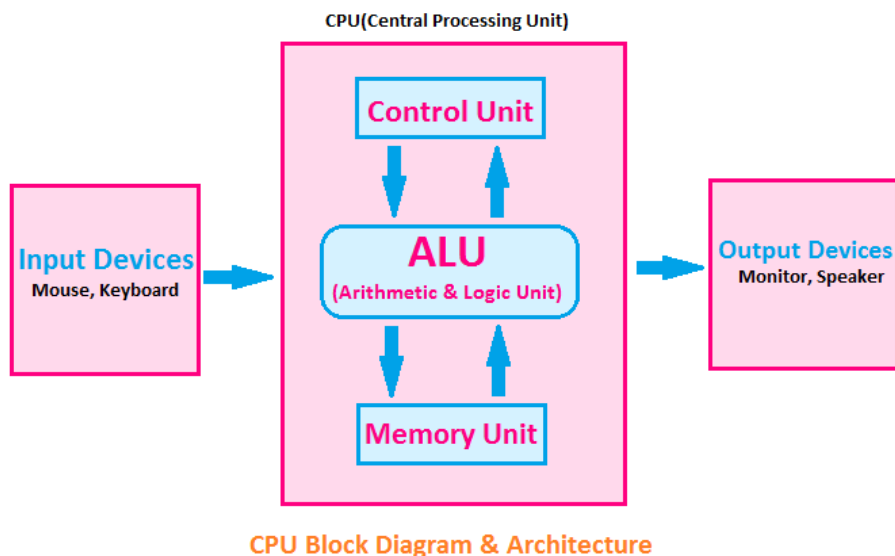
#### 4. Mobile Devices:

- Compact, touch-based devices like smartphones and tablets.
- **Features:**
  - Touchscreen interfaces and wireless connectivity.
  - Lower computational power compared to desktops and laptops but highly versatile.
  - Built-in sensors like GPS, accelerometers, and cameras.
- **Applications:**
  - Used for communication, online transactions, multimedia consumption, and casual gaming.
  - Increasingly employed in education and healthcare for mobility and convenience.
- **Examples in Nepal/Asia:**
  - Smartphones are the primary internet access devices in Nepal, especially in rural areas.
  - Tablets are used in Nepalese schools for digital learning and multimedia presentations.



## 2.3 Hardware Components

- Hardware components are the physical elements of a computer system.
  - They work together to perform the input, processing, storage, and output functions required for computing tasks.
- Below is a detailed breakdown of hardware components:



### ➤ Input Devices:

- Tools like keyboards, mice, and scanners.
- Input devices allow users to interact with a computer by entering data and instructions.
- **Examples:**
  - **Keyboards:** Used for typing.
  - **Mice:** Used for navigation and selection.
  - **Scanners:** Convert physical documents into digital format.
  - **Touchscreens:** Allow direct interaction with the display.
- **Example in Nepal/Asia:**
  - Touchscreen ATMs in Nepal enable easy financial transactions.

### ➤ Output Devices:

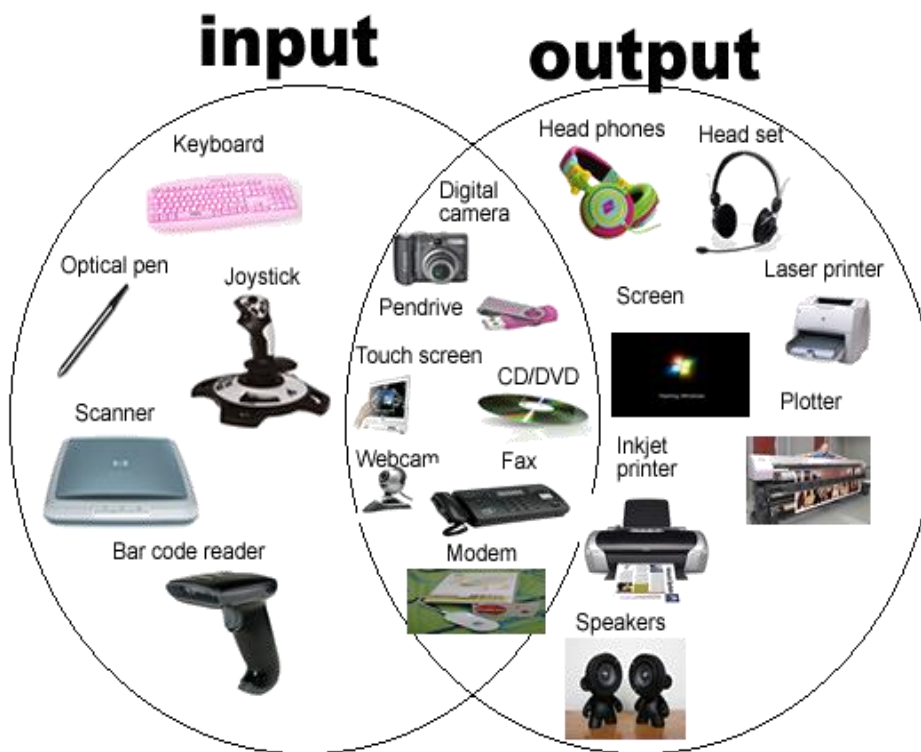
- Monitors, printers, and speakers.
- Output devices display or present processed information from the computer.
- **Examples:**
  - **Monitors:** Show visual output.
  - **Printers:** Produce hard copies of digital files.
  - **Speakers:** Output audio signals.
  - **Braille Readers:** Provide tactile output for visually impaired users.
- **Example in Nepal:**
  - Printers are widely used in government offices for producing official documents.

### ➤ Processing Unit/ Central Processing Unit (CPU):

- Includes the CPU and GPU for running instructions and graphical processing.

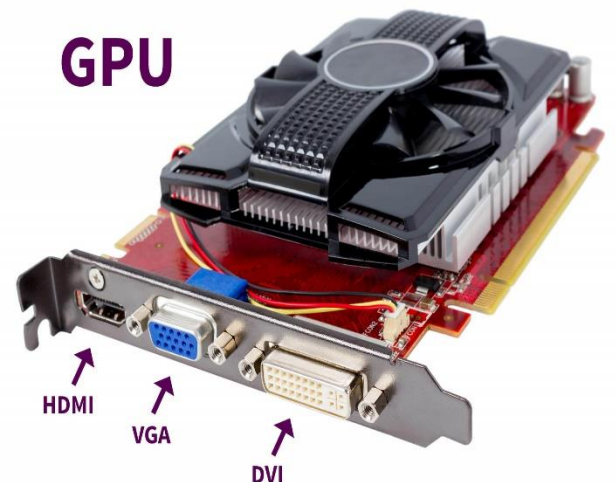


- The CPU, known as the "brain" of the computer, executes instructions and processes data.
- **Components:**
  - **Control Unit (CU):** Directs operations and manages data flow.
  - **Arithmetic Logic Unit (ALU):** Handles mathematical and logical computations.
  - **Registers:** Temporary storage for quick access to data during processing.
- **Storage Devices:** Internal HDDs/SSDs and external drives for data storage



### ➤ Graphics Processing Unit (GPU)

- Specialized hardware for rendering images and video.
- **Applications:**
  - Used in gaming, video editing, and machine learning applications.
- **Example in Nepal/Asia:**
  - GPUs are increasingly used by Nepalese designers and architects for 3D modeling.

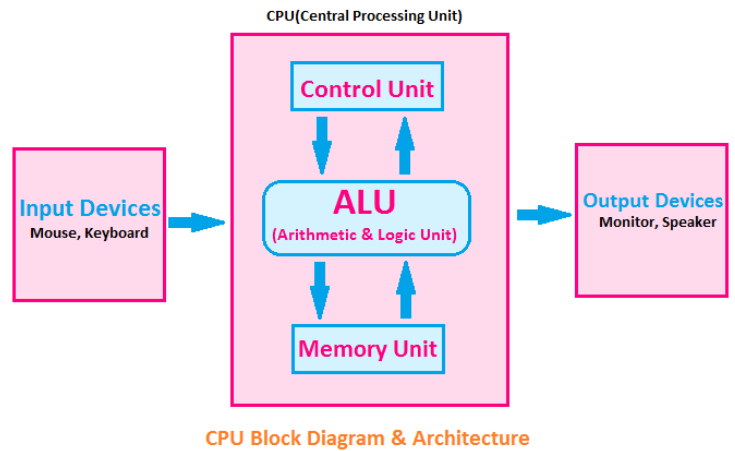


© TechTerms.com

## 2.4 Central Processing Unit (CPU)

- **Definition:** The CPU is the primary processing unit that executes instructions to perform tasks.
- **Components:**

- **Control Unit (CU):** Directs the flow of data and instructions.
- **Arithmetic Logic Unit (ALU):** Handles mathematical and logical operations.
- **Registers:** Small storage areas for quick access to frequently used data.



**Example:** Intel Core i7 processors are popular in high-performance laptops used in Nepal.



## 2.5 Memory (RAM, ROM)

- Memory is a critical component of a computer system, enabling data storage and access.
- It is broadly categorized into volatile and non-volatile memory.
- Below is an in-depth explanation of **RAM (Random Access Memory)** and **ROM (Read-Only Memory)**, their types, functions, and applications.

- **RAM (Random Access Memory):**
  - RAM is **volatile memory**, meaning it loses data when power is turned off. It temporarily stores data and instructions that the CPU needs during operation.
  - **Characteristics:**
    - **Volatile:** Requires constant power to retain data.
    - **Fast:** Provides quick access to frequently used data.
    - **Temporary**
  - **Types of RAM:**





- **DRAM (Dynamic RAM):**
  - Stores data using capacitors that need periodic refreshing.
  - Slower but cheaper and widely used in general-purpose systems.
  - Example: Found in laptops and desktops in Nepal.
- **SRAM (Static RAM):**
  - Uses flip-flops to store data, eliminating the need for refreshing.
  - Faster but more expensive than DRAM.
  - Example: Used in cache memory in high-performance servers in Asia.
- **Applications:**
  - Multitasking (running multiple programs simultaneously).
  - Gaming and video editing, where high-speed memory access is crucial.
  - Virtualization in servers, which demands large RAM capacities.
- **Examples in Nepal/Asia:**
  - Nepalese educational institutions use systems with 8 GB or more RAM for e-learning platforms.
  - High-end laptops with 16 GB RAM are popular among Nepalese software developers.

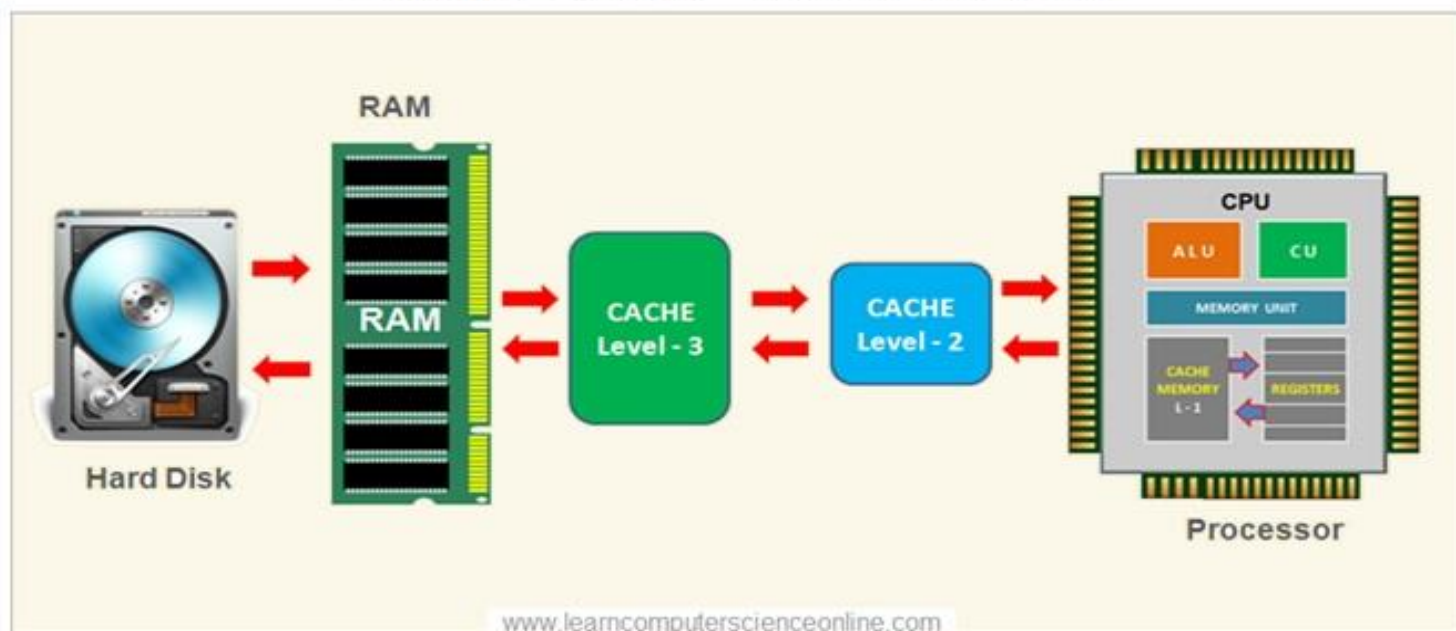
➤ **ROM (Read-Only Memory):**

- ROM is **non-volatile memory**, meaning it retains data even when the computer is powered off. It stores essential instructions for the computer's startup process.
- **Characteristics:**
  - **Non-volatile:** Data is permanently stored.
  - **Pre-programmed:** Contains factory-written data, typically not user-modifiable.
  - **Slower than RAM:** Access speeds are lower compared to RAM.
- **Types of ROM:**
  1. **PROM (Programmable ROM):**
    - Can be programmed once after manufacturing.
    - Example: Used in Nepalese embedded systems for control devices.
  2. **EPROM (Erasable Programmable ROM):**
    - Can be erased and reprogrammed using UV light.
    - Example: Used in firmware updates in Nepalese electronics.
  3. **EEPROM (Electrically Erasable Programmable ROM):**
    - Data can be erased and rewritten electrically.
    - Example: Used in Nepalese mobile devices for BIOS updates.
  4. **Flash Memory:**
    - A modern variant of EEPROM that is faster and more durable.



- Example: Found in USB drives and SSDs used by Nepalese businesses.
- **Applications:**
  - Storing firmware (BIOS/UEFI) that initializes hardware during startup.
  - Embedded systems like smart TVs and industrial machines.
  - Mobile devices for OS and application storage.
- **Examples in Nepal/Asia:**
  - Nepal Telecom's routers use ROM for firmware storage.
  - EEPROM is used in Nepalese smart cards for secure data storage.

## Computer System - Memory Hierarchy

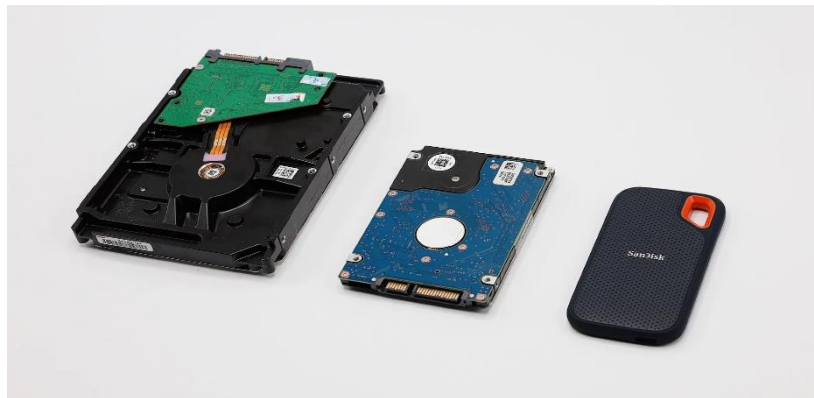


## Comparison of RAM and ROM

Feature	RAM	ROM
<b>Volatility</b>	Volatile (data lost on power off)	Non-volatile
<b>Purpose</b>	Temporary storage for active use	Permanent storage of firmware
<b>Speed</b>	Faster	Slower
<b>Data Modifiability</b>	Fully modifiable	Typically non-modifiable

## 2.6 Storage Devices (Hard Drives, SSDs, External Storage)

- Storage devices are critical hardware components for saving and accessing data in a computer system.
- They come in various forms, each designed to meet specific needs for speed, capacity, and portability.
- Here's a detailed breakdown of different types of storage devices:



### ➤ Hard Drives (HDDs):

- Magnetic storage for bulk data.
- HDDs are mechanical storage devices that use spinning disks (platters) coated with a magnetic material to store data.
- **Components:**
  - **Platters:** Store data magnetically.
  - **Read/Write Head:** Moves across the disk to read or write data.
  - **Spindle Motor:** Spins the platters at high speeds.
- **Working Principle:**
  - Data is read or written by magnetizing the material on the spinning platters using the read/write head.
- **Features:**
  - **Capacity:** Typically ranges from hundreds of GB to several TB.
  - **Speed:** Slower compared to SSDs (e.g., 5400 or 7200 RPM).
  - **Durability:** Prone to mechanical wear and tear.
- **Applications:**
  - Mass storage in desktops, servers, and backup systems.
  - Archiving large files like videos or databases.
- **Examples in Nepal/Asia:**
  - HDDs are commonly used in small businesses in Nepal for cost-effective data storage.
  - They are widely used in surveillance systems for recording CCTV footage in Asia.



### ➤ Solid State Drives (SSDs):

- Faster, more reliable storage than HDDs.
- SSDs are non-mechanical storage devices that use flash memory to store data. They have no moving parts, which makes them faster and more reliable.
- **Components:**



- **Flash Memory Chips:** Store data electronically.
- **Controller:** Manages data flow and optimizes performance.
- **Working Principle:**
  - Data is stored using floating-gate transistors that retain an electrical charge to represent binary data.
- **Features:**
  - **Speed:** Faster read/write speeds compared to HDDs.
  - **Durability:** More resistant to physical shock due to the lack of moving parts.
  - **Capacity:** Ranges from 128 GB to several TB.
- **Applications:**
  - Boot drives in laptops and desktops for faster startup and operation.
  - High-performance systems used for gaming, data analysis, and video editing.
- **Examples in Nepal/Asia:**
  - SSDs are gaining popularity among Nepalese gamers and professionals for improved system performance.
  - Asian data centers increasingly rely on SSDs for faster database processing.



- **External Storage:**
  - USB drives, external HDDs for portable data storage.
  - External storage devices are portable storage options used for data transfer, backups, and additional storage needs.
  - **Types of External Storage Devices:**
    - **External Hard Drives:**
      - HDDs housed in an external casing with USB or Thunderbolt connectivity.
      - Applications: Backing up personal or professional data in Nepal.
    - **External SSDs:**
      - Faster and more durable than external HDDs, used for on-the-go high-speed data access.
      - Applications: Used by photographers in Nepal for storing high-resolution images.
    - **USB Flash Drives:**
      - Compact and highly portable devices with storage capacities ranging from a few GBs to 1 TB.



- Applications: Widely used by students in Nepal for sharing files and projects.

- **Memory Cards:**

- Small, portable storage used in devices like cameras and smartphones.
- Applications: Nepalese photographers use SD cards for storing images during shoots.

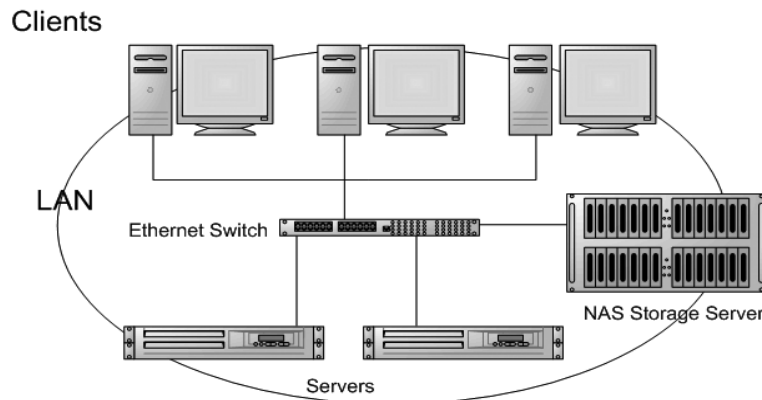


- **Network-Attached Storage (NAS):**

- Applications: Used by Nepalese businesses for collaborative file sharing.
- Dedicated devices connected to a network for shared storage.



## Network Attached Storage



## 2.7 Input and Output Devices (Working principle, application)

Overview: These devices allow interaction between users and computers.

### 2.7.1 Keystroke Devices

- Examples: Keyboards for data entry.
- Application: Used extensively in Nepal for office and educational purposes.

### 2.7.2 Touch Devices

- Examples: Touchscreens in smartphones and tablets.
- Application: ATMs in Nepal use touch interfaces for transactions.



### 2.7.3 Voice-Controlled Devices

- **Examples:** Smart assistants like Google Assistant.
- **Application:** Nepali users use voice input for setting reminders.

### 2.7.4 Movement-Controlled Devices

#### \* **Game Controllers (joysticks, gamepads, and VRcontrollers.),**

Game Controllers: Joysticks, gamepads for gaming.

- Example: Used by Nepalese gamers for PC and console games.

#### \* **Gesture-Control Devices, Leap Motion for touchless interaction.**

Gesture-Control Devices: Devices like Leap Motion for touchless interactions.

- Application: Used in advanced gaming in Asia.

### 2.7.5 Brain-Computer Interface (BCI):

- **Definition:** A direct interface between the brain and the computer.
- **Example in Asia:** Research institutions in India explore BCI for medical applications.

### 2.8.6 Wearables:

#### \* **Smart glasses, AR/VR headsets (e.g., Oculus, HoloLens).**

- Augmented Reality glasses like HoloLens.
- **Example:** AR devices are being explored for tourism in Nepal.

### 2.7.7 Haptic Feedback Gloves:

- **Definition:** Gloves providing tactile feedback for VR systems.
- **Example:** Used in VR simulations in advanced training centers in Asia.

### 2.7.8 Biosensors:

- Definition: Track physiological data like heart rate.
- Example in Nepal: Fitness wearables used by trekkers for safety.
  - \* Devices that track physiological data (e.g., heart rate monitors).

### 2.7.9 Data Scanning Devices

#### \* Barcodes, QR code scanners.

Barcode/QR Scanners: Used for retail and payment systems.

- Example: QR scanners in Nepal are popular for digital payments.

#### \* RFID:

Radio Frequency Identification scanners for contactless identification.

Used for contactless tracking in logistics.

#### \* Biometric Scanners:

Fingerprint, iris scanners.

Devices for fingerprint and iris recognition.

- Example in Nepal: Used in banks for secure transactions.

### 2.7.10 Digitizers:

- Definition: Devices like graphic tablets for drawing and design.
- Example: Used by Nepalese graphic designers for digital art
  - \* Graphics tablets, touch-sensitive stylus input.

### 2.7.11 Microphones:

- Examples: Analog and digital microphones for voice input.
- Application: Used for podcasting and interviews in Nepal.

\* Analog, digital, condenser microphones for voice input.

## 2.7.12 Electronic Cards Based Devices

\* Smart cards, debit/credit cards with NFC/RFID technology.

□ Definition: Devices using NFC or RFID for payment or access control.

□ Example: Smart cards are used for public transportation in Nepal.

## 2.7.13 Speech Recognition Devices

- Examples: Tools like Google Voice for dictation.
- Application: Nepali language is increasingly supported in speech-to-text systems.

## 2.7.14 Vision-Based Devices

\* Cameras, LiDAR, infrared sensors, facial recognition systems.

□ Cameras: Webcams for video conferencing.

□ LiDAR: Advanced sensors for depth mapping.

□ Facial Recognition: Used in security systems.

- Example in Asia: Airports in India employ facial recognition for immigration checks.

## 2.8 Output Devices (Working principle, application)

Output devices convert processed data from a computer into human-perceivable formats like visuals, sound, or tactile feedback. Below is a detailed breakdown of common output devices, their working principles, and applications:

\* **Monitors: CRT, LED, OLED screens.**

□ CRT (Cathode Ray Tube): Uses electron beams directed at a phosphorescent screen to produce images.

□ LED (Light Emitting Diode): Utilizes a liquid crystal display backlit by LEDs for sharper, more energy-efficient visuals.

□ OLED (Organic Light Emitting Diode): Each pixel emits light, offering better contrast and flexibility for curved screens.

**Applications:**

- **CRT:** Older televisions and computer monitors.
- **LED:** Commonly used in laptops, desktops, and TVs in Nepal.
- **OLED:** High-end TVs, smartphones, and foldable displays in Asia.

**\* Printers: Inkjet, laser, 3D printers.**☐ Working Principle:

- Inkjet: Sprays tiny droplets of liquid ink onto paper to produce high-resolution prints.
- Laser: Uses a laser beam to create static electricity on a drum, which attracts toner particles transferred to paper.
- 3D Printers: Build objects layer by layer using materials like plastic, resin, or metal, guided by a digital model.

☐ Applications:

- Inkjet: Used for home and office printing in Nepal.
- Laser: Preferred for bulk printing in Nepalese government offices and educational institutions.
- 3D Printers: Prototyping in industries like architecture, with growing applications in Nepal.

**\* Projectors: DLP, LCD.**☐ Working Principle:

- DLP (Digital Light Processing): Uses micro mirrors to reflect light onto a screen.
- LCD (Liquid Crystal Display): Channels light through LCD panels to project images.

☐ Applications:

- DLP: Used in theaters and conference rooms for high-resolution projections.
- LCD: Popular in classrooms and offices for presentations in Nepal.

**Audio Output: Speakers, headphones, and surround sound systems.**

- ☐ Speakers: Use electromagnetic induction to convert electrical signals into sound waves.
- Headphones: Function similarly to speakers but are designed for personal listening.

- **Surround Sound Systems:** Combine multiple speakers to create an immersive audio experience using advanced audio encoding.

□ **Applications:**

- **Speakers:** Used in homes, schools, and events in Nepal for communication and entertainment.
- **Headphones:** Widely used by students in Nepal for online classes.
- **Surround Sound:** Increasingly popular in Asian home theater setups.

## **Tactile Output: Braille readers, haptic feedback systems.**

□ **Working Principle:**

- **Braille Readers:** Use raised dots that change dynamically to represent text for visually impaired users.
- **Haptic Feedback Systems:** Generate vibrations or pressure to simulate touch sensations.

□ **Applications:**

- **Braille Readers:** Used in libraries and institutions for the visually impaired in Nepal.
- **Haptic Systems:** Deployed in VR systems and gaming devices in Asia for immersive experiences.