
UNIT – IV

Input Devices: Keyboard, Mouse, joystick, MICR, OCR, Barcoding, Speech

Output Devices: Printers, Plotter, VDU, Graphic Display Devices.

INPUT DEVICES

The computer will be of no use unless it is able to communicate with the outsideworld. Input/Output devices are required for users to communicate with the computer.

In simple terms, input devices bring information INTO the computer and outputd evices bring information OUT of a computer system. These input/output devices are also known as peripherals since they surround the CPU and memory of a computer system. **Input devices** are hardware devices that allow data to be entered into a computer.

The computer will be of no use if it is not communicating with the external world. Thus, a computer must have a system to receive information from the outside world and must be able to communicate results to the external world. Thus, a computer consists of input/output devices. Input and output devices can also be written as I/O devices.

Input and output devices of a computer system are the devices that connect you to computer. Input devices let you to transfer data and user command into the computer system. I/O devices are used to interact with the computer system. For example, you can type in data by using a keyboard, or you can input data in picture form by using a scanner in computer system.

An input device presents data to the processing unit in a machine-readable form. Although the keyboard is a common input device for a small computer, a system may also support various other input devices such as Optical Character Recognition (OCR), Magnetic Ink Character Recognition (MICR), mark sense reader, etc.

Manual Input devices: Data is input into the computer by hand. Manual input devices require humans to do most of the work needed to get data into the system. (eg.) Keyboard, Mouse, Tracker ball, Joystick, graphics tablet, digital camera, Webcam, microphone, touch screen, chip and pin

Direct Input devices (automatic input devices): Data is input into the computer directly by a machine or device. Direct input devices do not require much human interaction to get their data into a computer system. (eg.) Barcode scanner, Magnetic stripe reader, OMR reader, OCR reader, biometric scanner, Sensor.

KEY BOARD

The keyboard is the most common and widely used input device. It is made up of buttons called 'keys'. The keys are arranged into sections:

- Alphabet keys
- Function or F keys (F1, F2, F3)
- Numeric keys (one set above the alphabet keys and a numeric keypad on the right)
- Arrow keys
- Command keys (insert, delete, home, end, page up/down)

Keyboards are used to input **Text, numbers** and **instructions** into the computer. Most keyboards use a **QWERTY** key layout. This name comes from the first six letters on the top row of the alphabet keys.

Special keyboards called “**Ergonomic keyboards**” have built-in-hand-rest which prevents health issues such as RSI (Repetitive Strain Injury). Ergonomic keyboards have natural shape to reduce stress on wrist and hands.

A **concept keyboard** is a specialized keyboard with no pre-set keys. It relies on a touch sensitive screen with the key or overlay displayed on the screen. Each key can be programmed with a wide range of different functions. The overlay is often used as a quick and easy way to input items without needing to type anything or use a mouse. If you go to a fast food restaurant, the assistant will normally be using a concept keyboard. Pictures and icons can replace words and means that the assistant can quickly enter the order without having to use a keyboard.

Numeric keypads are used for entering numbers into a computer system. Some numeric keypads allow you to enter simple text and symbols. Numeric keypads are found in ATM (Automatic Teller Machines), telephones and chip and pin device. Electronic point of sale (EPOS) terminals has numeric keypads in case the barcode reader fails.

Uses of keyboard:

- Keyboards are used to enter text, numbers and instructions into applications like Word and Excel.
- Keyboards can also be used to enter commands(keyboard shortcuts) into the computer

Advantages of keyboards:

1. Enable fast entry of data.
2. Most computers come with a keyboard supplied
3. People need very little training to use keyboard.

Disadvantages of keyboards:

1. Keyboards are large and can take up a lot of desk space.
2. Keyboards are not suitable for creating diagrams.
3. Excessive use can lead to health problems such as repetitive strain injury (R.S.I.)
4. Entering data is slow compared to automatic methods. For example a barcode scanner will input data into the computer almost instantly.

Alphanumeric Keypad

It consists of keys for English alphabets, 0 to 9 numbers, and special characters like +
- / * () etc.

Function Keys

There are twelve function keys labeled F1, F2, F3... F12. The functions assigned to these keys differ from one software package to another. These keys are also user programmable keys.

Special-function Keys

These keys have special functions assigned to them and can be used only for those specific purposes. Functions of some of the important keys are defined below.

Enter

It is similar to the 'return' key of the typewriter and is used to execute a command or program.

Spacebar

It is used to enter a space at the current cursor location.

Backspace

This key is used to move the cursor one position to the left and also delete the character in that position.

Delete

It is used to delete the character at the cursor position.

Insert

Insert key is used to toggle between insert and overwrite mode during data entry.

Shift

This key is used to type capital letters when pressed along with an alphabet key. Also used to type the special characters located on the upper-side of a key that has two Characters defined on the same key.

Caps Lock

Cap Lock is used to toggle between the capital lock features. When 'on', it locks the alphanumeric keypad for capital letters input only.

Tab

Tab is used to move the cursor to the next tab position defined in the document. Also, it is used to insert indentation into a document.

Ctrl

Control key is used in conjunction with other keys to provide additional functionality on the keyboard.

Alt

Also like the control key, Alt key is always used in combination with other keys to perform specific tasks.

Esc

This key is usually used to negate a command. Also used to cancel or abort executing programs.

Numeric Keypad

Numeric keypad is located on the right side of the keyboard and consists of keys having numbers (0 to 9) and mathematical operators (+ - * /) defined on them. This keypad is provided to support quick entry for numeric data.

Cursor Movement Keys

These are arrow keys and are used to move the cursor in the direction indicated by the arrow (up, down, left, right).

MOUSE

Mouse is a device that controls the movement of the cursor or pointer on a display screen. It is a small object you can roll along a hard and flat surface. As you move the mouse, the pointer on the display screen moves in the same direction. Mouse contains at least one button and sometimes as many as three, which have different functions depending on what program is running.

The mouse is a small device used to point to a particular place on the screen and select in order to perform one or more actions. It can be used to select menu commands, size windows, start programs etc.

The most conventional kind of mouse has two buttons on top: the left one being used most frequently. Mouse Actions

Left Click :Used to select an item.

Double Click : Used to start a program or open a file.

Right Click : Usually used to display a set of commands.

Drag and Drop : It allows you to select and move an item from one location to another. To achieve this place the cursor over an item on the screen, click the left mouse button and while holding the button down move the cursor to where you want to place the item, and then release it.

Types of Mouse: Mouse could be mechanical, optical or cordless types. Further information regarding these types are as follows:

Mechanical Mouse : Mechanical Mouse uses ball for the movement of cursor on the computer screen. When the ball is rolled in any direction, a sensor of the mouse detects it and also moves the mouse pointer in the same direction.

Optical Mouse : Optical Mouse uses Laser rays for the movement of cursor on the computer screen. It is an advanced pointing device. Movement is detected by sensing changes in the reflected light rather than the motion of a rolling sphere.

Cord-Less Mouse : Cord-Less Mouse is battery driven and does not need any wire for the physical connection with the motherboard. It transmits data through infrared or radio signal. Computer mice are very useful in designing pictures and graphs and computer and video games by multimedia designers. A Mouse pad is required to move the mouse because it provides a smooth surface. However, an optical or laser mouse doesn't require a mouse pad.

Uses of Mouse:

1. Opening, closing, Maximizing and Minimizing programs and files.
2. Moving, grouping and deleting files
3. Controlling a pointer on a screen to select icons or move around the page.
4. Editing images in terms of size and position on the screen.

Advantages of Mouse:

1. Ideal for use with desktop computers.
2. Works well in conjunction with a keyboard for data entry.
3. It is small in size and do not take up much space.
4. Faster to select icons and options when compared to a keyboard.

Disadvantages of Mouse:

1. Excessive use can lead to health problems such as repetitive strain injury (R.S.I.)
2. Older style mouse which has roller balls can become clogged with grease and grime and lose their accuracy until cleaned.
3. Mouse needs a flat surface in order to work properly.
4. If the battery wears out in a wireless mouse, it cannot be used until it has been replaced

Joystick

A joystick is used as a personal computer peripheral or general control device consisting of a hand-held stick that pivots about the base and steers the screen cursor around. Most joysticks are two-dimensional, having two axes of movement (similar to a mouse), but three-dimensional joysticks do exist. A joystick is generally configured so that moving the stick left or right signals movement along the X-axis, and moving it forward (up) or back (down) signals movement along the Y-axis.

In joysticks that are configured for three dimensional movement, twisting the stick left (counter-clockwise) or right (clockwise) signals movement along the Z-axis. In conventional joystick potentiometers, or variable resistors, are used to dynamically detect the location of the stick and springs are there to return the stick to centre position as it is released.

In many joysticks, optical sensors are used instead of analog potentiometer to read stick movement digitally. One of the biggest additions to the world of joysticks is force feedback technology. On using a force feedback (also called haptic feedback) joystick if you're shooting a machine gun in an action game, the stick would vibrate in your hands. Or if you crashed your plane in a flight simulator, the stick would push back suddenly which means the stick moves in conjunction with onscreen actions.

Joysticks are often used to control games, and usually have one or more push-buttons whose state can also be read by the computer. Most I/O interface cards for PCs have a joystick (game control) port. Joysticks were popular during the mid-1990s for playing games and flight-simulators, although their use has declined with promotion of the mouse and keyboard. Joysticks are also used for controlling machines such as cranes, trucks, underwater unmanned vehicles, flight simulators, industrial robots etc.



Joy stick

Uses of Joystick:

1. To control characters or objects in video games.
2. To control **industrial machinery** such as cranes.
3. They are used in **simulators**.(eg.) Trainee pilots use joysticks to control the simulate plane.

Advantages of joystick:

1. They give a better gaming experience for racing or flying styles of computer games.
2. Easier to control an on screen cursor or move an in-game character.

Disadvantages of joysticks:

1. Difficult to input text with joystick than with keyboard.
2. Not as easy to control an on screen cursor when compared to using a mouse.
3. People with hand/wrist issues can find them painful to use.

Magnetic Ink Character Recognition (MICR)

A **magnetic ink character recognition (MICR) reader** can read text printed with magnetized ink. Magnetic ink character recognition is used most exclusively by the banking industry for processing checks. The characters represent the check number, the bank number, and the account number of customers.

An MICR can identify characters printed with a special ink that contain particles of magnetic material. This device particularly finds applications in banking industry. Since the MICR system can recognise only certain character styles, the characters have to be accurately formed.

Magnetic Ink Character Recognition is a character recognition system that uses special ink and characters. When a document that contains this ink needs to be read, it passes through a machine, which magnetizes the ink and then translates the magnetic information into characters.

MICR technology is used by banks for faster processing of large volumes of cheques. Numbers and characters found on the bottom of checks (usually containing the check number, sort number, and account number) are printed using Magnetic Ink. To print Magnetic Ink codes, we need a laser printer that accepts MICR toner.

MICR provides a secure, high-speed method of scanning and processing information. This technology is used for processing large volume of data. It speeds up data input for the bank because cheques can be directly fed into the input device as it also ensures accuracy of data entry. The most commonly used character set by MICR devices are known as E13B font which consists of the numerals 0 to 9, and four special characters.

MICR software scans documents for numerals and symbols printed in magnetic ink. The use of magnetic ink makes documents harder to copy. MICR is mostly used by bank cheque-processing systems for input of printed items on the bottom of each cheque.

Advantages:

1. It is highly accurate to recognize numerals and symbols even if they are overprinted by visible marks.
2. MICR is difficult to forge.
3. Documents can still be read when folded or written on.

Disadvantages:

1. MICR readers are expensive and only detect magnetic ink characters.
2. MICR readers and encoders are very expensive.
3. The system can only accept a few different character sets.
- 4.

OCR:

Optical Character Recognition (OCR) software's are intelligent programs which can convert a scanned page of text into editable text either into a plain text file, a Word document or even an Excel spreadsheet which can be easily edited. OCR can also be used to scan and recognize printed, typewritten or even handwritten text.

The OCR software requires a raster image as an input, which may be an existing image file or an image transferred from a scanner. OCR analyzes the image to find blocks of image information that resemble possible text fields and creates an index of such areas.

Optical Character Recognition (OCR) is software which extracts the text from the image of scanned document. OCR software compares the shape of each possible text character in the image data with sample (template) for each character stored in computer. When it recognizes a character then adds it in the output data sequence.

Most **OCR readers** include a small optical scanner for reading characters and Sophisticated OCR software for analyzing what is read.

Advantages of OCR readers include

- ◆ Written data and printed data can be read at the same time.
- ◆ Hard copies of documents can be read directly into a computer without retyping.
- ◆ The characters converted can later be edited by word processing software.
- ◆ It is quicker to extract text from a document and to use it via word processor.
- ◆ It is useful for people with visual impairments because after extracting text from document, a text-to-speech software can be used to read it aloud.

Disadvantages of OCR readers include

- ◆ OCR readers often do not work well with handwritten characters or those in unusual fonts.
- ◆ The text recognized by OCR software is not always accurate.

Optical Mark Reading (OMR) :

Software is used to detect the presence of marks (shaded regions) in certain positions on a paper form. Unlike OCR, it cannot detect the characters. OCR software is used to extract marked answers in multiple-choice questions, survey results, votes in elections etc.

Advantage:

1. It is extremely fast and accurate because shaded regions are simple to detect.

Disadvantages:

1. Paper forms can be read accurately only if they are lined up properly.
2. The dirty marks on the paper can be read by OMR as well which leads to wrong results.

Bar coding:

A barcode reader is an electronic device which is used to read printed barcodes. Barcodes represent alphanumeric data which is a combination of vertical lines (bars) that vary in width and length. It is a fast and effective way to input data. A Barcode reader uses a laser beam to read the series of thick and thin lines which represent the bar code number.

The bar code is 13 digits long and it has four main divisions. The First two digits of a bar code represent the country, the second part represents the manufacturer's code (five digits) the third part represents the product code (five digits) and the last digit is a check digit.

A **barcode** is a set of parallel lines in contrasting colours usually black lines on a white background. Barcodes are used to identify items of merchandise, resources, membership cards or documents. A barcode may represent numeric digits or alphanumeric characters. A barcode only tells about the manufacturer and product only. A barcode reader is usually used at Point-of-Sale (POS).

Lines of different widths and sizes representing data, that when read determine what the scanned object is. Barcodes are often used to help organize and index information or prices about an object. Barcodes used by the U.S. postal service that helps speed the delivery of mail is another perfect example of how a barcode could be used. The picture is an example of what a barcode of an address.

A **barcode reader** is a combination of scanner hardware and software. The scanner captures the image of barcode while software decodes the barcode in captured image.

Barcode readers and scanners

A **barcode reader (BCR)** or **scanner**, also known as a **point of sale (POS) scanner** is a hardware device capable of reading a barcode. It can also print out the details of the product or log information about that product into a database. A perfect example of a barcode reader is a super market barcode scanner that reads and logs the price of a product. In the picture is an example of a Barcode reader from HP. Today, many smart phones with the proper apps are also capable of scanning and reading barcodes.

At POS, a barcode reader consists of a scanner wand or a LASER scanner fixed at the operator's computer. In these dedicated scanners a suitable processor and a decoding software are built-in the scanner. It sends signals of decoded barcode to the computer for further processing.



Barcode readers

Barcode Printers

A hardware device capable of printing out adhesive barcodes that can be attached to a product and identify a product and help keep inventory.

Advantages:

1. Codes can be entered much faster than keyboard.
2. Codes can be entered more accurately than a person.

Disadvantage:

1. Barcode is difficult to read or may be misread by barcode reader if it is obscured.

Speech

Speech or voice input devices convert a person's speech into digital form. These input devices, when combined with appropriate software, form voice recognition systems. These systems enable users to operate microcomputers using voice commands.

The voice-system or speech recognition system is a sophisticated input device that accepts voice or speech input from the user and transforms it into digital data that can be used to trigger graphic operations or enter data in specific fields. A dictionary is established for a particular operator (voice) by recording the frequency-patterns of the voice commands (words spoken) and corresponding functions to be performed. Later when a voice command is given by the same operator, the system searches for a frequency-pattern match in the dictionary and if found the corresponding action is triggered. If a different operator is to use the system then the dictionary has to be re-established with the new operator's voice patterns.



Operator's Speech Recording

For example to control a computer, navigate telephone menus, etc. These require that the voice first be recognized. A microphone is used to input the spoken words, which are then analysed by the program. The sound is compared with other sounds stored in the computer, to find the matching word; this match may be interpreted as a command. This is an unreliable process because a user can make words sound different at different times, and different users

will say the same words differently. As a result, the software may have to be trained to recognize a particular user.

The “Microphones - Speech Recognition” is a speech Input device. To operate it we require using a microphone to talk to the computer. Also we need to add a sound card to the computer. The Sound card digitizes audio input into 0/1s .A speech recognition program can process the input and convert it into machine-recognized commands or input.

1. Used to input sounds/speech for use in a range of applications. For example

- ◆ **Narration** in presentations or in web sites
- ◆ **Voice-over’s in movies**
- ◆ **Speaking over the internet using VoIP**(Voice over Internet Protocol)
- ◆ **Conducting video conferencing**

2. Used in speech recognition software. For example

- ◆ **Converting speech into text** for use in Word processors (useful for people who do not have use of their hands)

OUTPUT DEVICES:

Output device receives information from the CPU and presents it to the user in the desired form. The processed data, stored in the memory of the computer is sent to the output unit, which then converts it into a form that can be understood by the user. The output is usually produced in one of the two ways – on the display device, or on paper (hard copy). Output devices return processed data that is information, back to the user.

- Any peripheral that receives or displays output from a computer.
- Computer hardware equipment used to communicate the results of data processing carried out by a computer to the outside world

An output device is any piece of computer hardware equipment used to communicate the results of data processing carried out by an information processing system (such as a computer) which converts the electronically generated information into human-readable form.

An output device is used to send data out of the system. The user sees the result after processing of data by the computer through output devices. Examples of some output devices are:

- Printer
- Plotter
- VDU.
- Graphic display device.

PRINTERS

After a document is created on the computer, it can be sent to a printer for a hard copy (printout). Some printers offer special features such as colored and large page formats. Some of the most commonly used printers are:

1. Laser Printer
2. Ink Jet Printer
3. Dot Matrix Printer
4. Line Printer

Laser Printer: A laser printer produces high quality print that one normally finds in publishing. It is extremely fast and quiet. Moreover, the operation of a laser printer is easy with automatic paper loading and no smudging or messing up of ink ribbons. The fastest laser printer can print up to 200 pages per minute in monochrome (black and white) and up to 100 pages per minute in colour.

Ink-Jet Printer: An ink-jet printer creates an image directly on paper by spraying ink through as many as 64 tiny nozzles. Although the image it produces is not generally quite as sharp as the output of a laser printer, the quality of ink-jet images is still high.

In general, ink-jet printer offers an excellent middle ground between dot matrix and laser printer. Like laser printer, an ink-jet printer is quiet and convenient, but not particularly fast. Typically, an ink-jet printer is more expensive than a dot-matrix printer, but costs only half as much as a laser printer.

Dot Matrix Printer: The dot matrix printer was very popular at one point of time. It is a very versatile and inexpensive output device. In dot matrix printer the print head physically "hits" the paper through the ribbon and produces text (or images) by combinations of dots; hence the name dot matrix printer. Its speed is measured in characters per second (CPS). Although it is less expensive, it is louder, slower and produces lower print quality.

Line Printer: A line printer is generally used with large computer systems to produce text based data processing reports. Line printers are high-speed printers with speeds ranging anywhere from 100 to about 3800 lines per minute. In the past, print quality on line printers was not high. Developments in technology are improving the print quality on line printers. These are in the cost range of lacs of Rupees.

Printers are used to produce paper (commonly known as hardcopy) output. Based on the technology used, they can be classified as Impact or Non-impact printers.

Impact printers use the typewriting printing mechanism wherein a hammer strikes the paper through a ribbon in order to produce output. Dot-matrix and Character printers fall under this category.

Non-impact printers do not touch the paper while printing. They use chemical, heat or electrical signals to etch the symbols on paper. Inkjet, Deskjet, Laser, Thermal printers fall under this category of printers.

PLOTTER

A Plotter is a device that draws pictures on a page as output, after receiving a print command from the computer. It is also called a graph plotter. In plotters pens are used to draw lines on the paper, which is placed in the plotter.

A plotter is a special kind of output device that, like a printer, produces images on paper, but does so in a different way. Plotters are designed to produce large drawings or images, such as construction plans for buildings or blueprints for mechanical objects. A plotter can be connected to the port normally used by a printer.

An array of different colored pens in a clip rack and a robotic arm is part of plotter. The instructions that a plotter receives from a computer consist of a color, and beginning and ending coordinates for a line. With that information, the plotter picks up the appropriate pen through its arm, positions it at the beginning coordinates drops the pen down to the surface of the paper and draws to the ending coordinates. Plotters draw curves by creating a sequence of very short straight lines.

Plotters are used to print graphical output on paper. It interprets computer commands and makes line drawings on paper using multi-color automated pens. It is capable of producing graphs, drawings, charts, maps etc.

Plotters produce high quality diagrams on the paper and their output quality is good. Engineers, architects and planners use plotters to generate high quality, high-precision graphic output of different sizes. For several design applications such as design of layout of an aircraft, car, and architectural design of a building and in other computer-aided design applications plotter are very useful. Plotter is of two types:

- ◆ Drum Plotter
- ◆ Flat-Bed Plotter

1. Flat Bed: Plotters of small size to be kept on table with restriction of paper size.
2. Drum: These plotters are of big size using rolls of paper of unlimited length.



Plotter

The drum plotters are generally smaller than flatbed plotters and they have lower resolutions than flatbed plotters. HP, Canon and Epson are the popular companies which manufacture good quality of platters.

Visual Display Unit (VDU)

A monitor is a video display screen. Monitor is also called as Visual Display Unit (VDU) or Video Display Terminal (VDT).

Computer information is displayed, visually with a video adapter card and monitor. Information processed within the CPU, that needs to be visually displayed, is sent to video adapter. The video adapter converts information from the format used, in the same manner as a television displays information sent to it by a cable service.

When people talk about the capabilities of various monitors, one critical statistic is the resolution of the monitor. Most monitors have a resolution of at least 800 x 600 pixels. High-end monitors can have resolutions of 1024 x 768 pixels or even 1280 x 1024 pixels. Thus monitors are available either in low resolution or in high resolution.

- The device which displays computer output.
- The monitor displays the video and graphics information generated by the computer through the video card.
- Monitors are very similar to televisions but usually display information at a much higher resolution.

Monochrome Monitor

•A **monochrome monitor** is a type of CRT computer display which was very common in the early days of computing, from the 1960s through the 1980s, before color monitors became popular.

- They are still widely used in applications such as computerized cash register systems

Color Monitor

- Color monitors can display anywhere from 16 to over 1 million different colors.
- Color monitors are sometimes called RGB monitors because they accept three separate signals --red, green, and blue.

Types of Monitor

- Cathode Ray Tube (CRT)
- Liquid Crystal Display (LCD)
- Light-emitting Diode (LED)

Cathode Ray Tube (CRT)

Cathode Ray Tube (CRT): CRT or Cathode Ray Tube Monitor is the typical monitor that you see on a desktop computer. It looks a lot like a television screen, and works the same way. This type uses a large vacuum tube, called cathode ray tube (CRT).

- Large
- Heavy
- Produce heat
- Not expensive

Liquid Crystal Display (LCD)

Liquid Crystal Displays (LCD): This type of monitors are also known as flat panel monitor. Most of these employ liquid crystal displays (LCDs) to render images. These days LCD monitor are very popular.

- Less space
- Lighter
- Low power consumption
- Expensive
- Limited viewing angle

Light-emitting Diode (LED)

- Less space
- Lighter
- Very expensive
- Provide higher contrast and better viewing angles than LCD monitor

GRAPHIC DISPLAY DEVICE

CAD System uses various display devices and these display devices are the primary output devices. These devices are used to display graphical output on the screen to have a better visualization in real time. These devices not only display the image but are also used to interact with the image by adding deleting and modifying graphical entities on the screen. Thus due to interaction the graphics system are different from the passive graphic system, as in case of television.

Data output through graphic devices on computer systems is made possible through techniques that use video generation modules to display images. This differs from text mode output, for which the computer generates horizontal lines of **alphanumeric** symbols. Although the technical requirements of both systems overlap, graphic devices use an approach that assumes that every dot on the screen is separately accessible. By contrast, in text mode, the smallest screen element is actually a group of points that together all define a character—a letter, a numeral, or a punctuation mark.

A graphic display is composed of a screen or panel that is made up of a large number of small cells or dots that are called **pixels** . These pixels emit light when they are struck by a beam of electrons and switched on. At any one instant, the computer hardware can switch some pixels on fully so that they emit light, skip over others so that they remain dark, and prompt still others to emit an intermediate measure of light. In this way the representation of a picture can be displayed on a graphic device using every pixel as a separate component in the image.

Graphic devices are output devices, but their physical characteristics restrict them from taking data as represented in the computer's memory and displaying the data directly. Instead, they require the assistance of a special device to translate data into electrical signals that are compatible with the display hardware. These devices are called graphics controllers.

One way that data can be formulated for display by the computer is through a technique known as a **bitmapped display** or "raster-scan display." Using this approach, the computer contains an area of memory that holds all the data that are to be displayed. The central processor writes data into this region of memory and the video controller collects them from there. The bits of data stored in this block of memory are related to the eventual pattern of pixels that will be used to construct an image on the display.

The Graphics System are classified into the following types

1. Cathode Ray Tube (CRT)

- ◆ Raster Scan
- ◆ Random Scan

2. Solid State Monitors (Flat Panel Display)

- ◆ Emissive Display
- Plasma Display
- Thin Film Electroluminescent Display
- LCD (Liquid Crystal Display)
- ◆ Non-Emissive Display
- LED(Light Emitting Diode)

A CRT is a television-style monitor

- **Its features include:**
 - Clear image
 - Quick response time
 - Low cost
 - Very popular

Features of CRT Displays

- Display text and graphics
- Monitors differ in resolution
- Standards
 - SVGA – 1024 x 768, 1208 x 1024 and 1600 x 1200
 - XGA – has same resolutions but supports more colours
- Screen sizes vary from 15” to 21”

LCD (Liquid Crystal Display)

- LCDs comprise flat-panel monitors
- Found on watches, calculators, digital cameras and notebook computers
 - Lighter weight
 - Crisp, clear images
 - Extra viewing area for same size
 - More expensive to buy
 - Consume less power