**Chapter 5**

**Input and Output Devices**

*Lesson 5.1:* Input-Output Operations

*Lesson 5.2:* Input Devices

*Lesson 5.3:* Output Devices

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***Lesson 5.1***

***Input-Output Operations***

**2.1.0 Objectives**

*On completion of this lesson you will know:*

* *Input/output interfaces*
* *Input/output methods and communications*
* *Input media*

**5.1.1 I/O Interface**

Communications between an input/output (I/O) device and the microcomputer take place through an interface. The interface converts data from a form used by a device to a form acceptable by the other. It must also adjust for speed differences between the processor and I/O devices. The interface circuits used in microcomputer correspond to the I/O control units of larger systems. Two general types of interface devices in use are:

* Serial Interface, and
* Parallel Interface

**Serial Port and Serial Interface:** A serial port is associated with the serial interface and a serial I/O device is connected to a PC via the serial port. The serial port uses one line to send data, another line to receive data and few lines to control data flow. For its simplicity, a serial port is a general-purpose interface that can be used for almost any type of device including modems, mice and keyboards. Most serial ports on a PC conform to RS 232C or RS 422 standards. Ethernet, Fireware and USB all send data as a serial stream. A serial port is not very efficient way to transfer data as it sends 1 bit at a time. This inefficient data transfer, however, is acceptable for a mouse which transmits small data where speed is not crucial. Figure 5.1.1 shows how data flows through a nine-bit serial interface. A chip, called a universal asynchronous receiver-transmitter (UART), converts parallel data from the bus into serial data that flows through a serial cable.



**Figure 5.1.1**: Data flow through serial interface

**Parallel Port and Parallel Interface:** A parallel I/O device is connected to the PC through parallel port associated with their parallel interface. The parallel port has been synonymous with printer port since early days of microcomputers. A parallel port can send several bits of data, or an entire byte, across parallel wires simultaneously. Thus it can handle a high volume of data than a serial interface. Figure 5.1.2 shows how data moves through a parallel interface.



**Figure 5.1.1**: Data flow through parallel interface

Before the advent of USB, the parallel interface was adapted to access a number of peripheral devices such as zip drives, scanners, external modems, sound cards, webcams, external hard disk drives and CD-ROM drives. Adapters are available to run SCSI devices via parallel interface. Other devices such as EPROM programmers and hardware controllers could be connected via parallel port.

On a PC, the parallel port uses a 25-pin connector (DB-25) and is used to connect printers, computers and other devices that need relatively high bandwidth. It is often called a Centronics interface after the company that designed the original standard for parallel communication between a computer and a printer.

A newer type of parallel port, which supports the same connectors as the Centronics interface, is the Enhanced parallel port (EPP) or Extended Capabilities port (ECP). Both of these parallel ports supports bi-directional communication and transfer rate ten times as fast as the Centronics port. Macintoshes have a SCSI port, which is parallel, but more flexible.

**5.1.2 Input /Output Methods**

There are three basic I/O methods by which data can be read from or written to a peripheral device and RAM. These are programmed I/O, interrupt I/O and direct memory access (DMA)

**Programmed I/O:** In programmed I/O, a microprocessor controls of all transfers and other I/O operations. This is accomplished with specific input or output instructions. When an input operation is desired, the microprocessor simply issues an input command and awaits the arrival of data at the data bus. The data are moved to memory from the data bus. Similarly, if an output operation is desired, the microprocessor transmits data to the bus and issues a command to the output devices through appropriate interface. Once the data transfer is initiated, the microprocessor must wait for its completion and the bus to be freed before beginning a new transfer. This method is commonly used in PCs, because it is effective and easily implemented.

**Interrupt I/O**: This is a device initiated transfer. An interrupt transfer involves the I/O device sending a request to the processor through an interrupt input (INT) to inform the CPU that the I/O device is ready for data transfer. In response, the CPU interrupts the execution of its current program and jumps to a new program, called interrupt service routine, which contains instructions to transfer data to or from the interrupting device.

**DMA:** It is a technique for transferring data from main memory to a device without passing it through the CPU. Computers that have DMA channel can transfer data to and from devices much more quickly that computers without a DMA channel. This is useful for making quick backups and for real time applications. Some expansion boards, such as CD-ROM cards are capable of accessing a computer’s DMA channel. When a board is installed, DMA channel must be specified which may involve setting a jumper or DIP switch.

**5.1.4 Key points**

* Communications between an input/output (I/O) device and the microcomputer take place through an interface.
* The serial port uses one line to send data, another line to receive data and few lines to regulate data flow.
* A parallel port can send several bits of data, or an entire byte, across parallel wires simultaneously.
* A newer type of parallel port, which supports the same connectors as the Centronics interface, is the Enhanced parallel port (EPP) or Extended Capabilities port (ECP).
* In programmed I/O, a microprocessor controls of all transfers and other I/O operations.
* Interrupt I/O is a device initiated transfer.
* DMA is a technique for transferring data from main memory to a device without passing it through the CPU.

**5.1.5 Exercise**

**Multiple choice questions**

1. The fastest data transfer port is \_\_\_\_\_\_\_\_\_\_\_\_\_ port
   1. serial
   2. air
   3. parallel
   4. none
2. Which one is the faster, smaller and more reliable input media?
   1. paper
   2. magnetic
   3. optical
   4. solid state
3. Printer port is a \_\_\_\_\_\_\_\_ port
   1. air
   2. PS/2
   3. parallel
   4. none

**Question for Short Answer**

1. What is an I/O interface?
2. Distinguish between serial port and parallel port.
3. Name the different Input/output strategies.

**Analytical Question**

1. Describe the serial and parallel ports of computer system.
2. Explain different types of I/O methods.

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***Lesson 5.2***

***Input Devices***

**5.2.0 Objectives**

*On the completion of this lesson you will know:*

* *Keyborads*
* *Pointing and Scanning devices*
* *Reading Devices*
* *Other input devices*

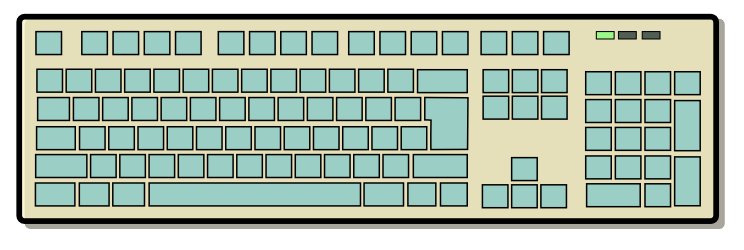
**5.2.1 Keyborad**

Keyboard is an input device that is used to enter data to a computer. The entered data are then converted into machine language so that a CPU understands the data or instruction coming through the input devices.

Computer keyboards are similar to electric-typewriter keyboards but contain additional keys. The keys on computer keyboards are often classified as: alphanumeric keys for letters and numbers; Modifier keys such as SHIFT, ALT (alternate), CTRL (control); Numeric Keypad such as +, - &, \* so on; Function keys like F1, F2 so on; and Special purpose key such as Start (windows logo); Cursor-movement key.

The standard layout of letters, numbers, and punctuation is known as a QWERTY keyboard because the first six keys on the top row of letters spell QWERTY. The QWERTY keyboard was designed in the 1800s for mechanical typewriters and was actually designed to slow typists down to avoid jamming the keys. Another keyboard design, which has letters positioned for speed typing, is the Dvorak keyboard.

There are at least four ways to connect a keyboard to a computer. These are Serial, PS/2, USB and Cordless (wireless). Serial and PS/2 are obsolete now. USB and Cordless or wireless mouse are the most dominant for the modern computers. Figure 5.2.1 shows a diagram of a QWERTY keyboard.



***Figure 5.2.1: A QWERTY keyboard***

**5.2.2 Reading devices**

**Magnetic Ink character Reader:** American National Standards Institute (ANSI) defines Magnetic Ink Character Recognition (MICR), which is the common machine language specification for the paper-based payment transfer system. It is used extensively in banking because magnetic-ink characters can be machine-read with much greater accuracy than human reading or other optical character recognition (OCR) systems.

The MICR encoding, called the MICR line, is at the bottom of cheques and typically includes the document-type indicator, [bank code](http://en.wikipedia.org/wiki/Bank_code), [bank account number](http://en.wikipedia.org/wiki/Bank_account_number), cheque number, cheque amount, and a control indicator as shown in Figure 5.2.2.



***Figure 5.2.2: MICR on bank cheque***

**Optical Mark Reader:** An optical mark reader (OMR) is a device that can read human-marked data that have been placed in specific places on a form or card. The OMR is used mainly for survey and tests. It requires very little training or instruction to use the forms or cards and also good for multiple choice questionnaires. But it has the following disadvantages

* Can only input a limited data set
* Poorly marked forms/cards cause errors.
* Creased/folded forms cause errors.

http://www.teach-ict.com/as_a2/topics/hardware/input%20devices/images/hover.jpghttp://www.teach-ict.com/as_a2/topics/hardware/input%20devices/images/base.jpg**Optical Character Recognition:** Optical character recognition (OCR) device translates scanned images of handwritten, typewritten or printed text into machine-encoded text. It is widely used to convert books and documents into electronic computer file which can be edited using a word processor. OCR is a field of research in pattern recognition, artificial intelligence and computer vision.

All OCR systems include an optical scanner for reading text, and sophisticated software for analyzing images. Most OCR systems use a combination of hardware (specialized circuit boards) and software to recognize characters, although some inexpensive systems do it entirely through software. Advanced OCR systems can read text in large variety of fonts, but they still have difficulty with handwritten text. Figure 5.2.3 shows an optical character recognition process.

The potential of OCR systems is enormous because they enable users to harness the power of computers to access printed documents. OCR is already being used widely in the legal profession, where searches that once required hours or days can now be accomplished in a few seconds.



***Figure 5.2.3: Optical character recognition process***

**Smart Card Reader:** A smart card reader is an electronic device that reads smart cards which is a microchip or possibly an embedded integrated circuit (IC). Smart cards containing an IC are sometimes called Integrated Circuit Cards (ICCs). Smart cards are used for a variety of purposes, including: storing a patient's medical records, storing digital cash, storing employee information in office, paying bills, buying merchandise, making phone calls, buying postal money order, getting examination results etc.

To use a smart card, either to pull information from it or add data to it, a smart card reader is needed, a small device into which the smart card is inserted. Figure 5.2.4 shows a smart card reader and a smart card.



***Figure 5.2.4: Smart card reader and smart card***

**5.2.3 Pointing devices**

**Mouse:** The mouse is a pointing device used to move a cursor on the screen and allowing objects to be selected, moved and manipulated using the buttons. The consistent action of pressing (clicking) on a button in order to carry out an action is called a "click". In multi-button a mouse, one button is primary button (left button for right handed user). The operation of the buttons can be configured by computer’s operating system, application software and mouse-control software.

The first mouse was invented and developed by Douglas Carle Engelbart of Stanford Research Institute (SRI) of USA. It was a wooden mouse containing two perpendicular discs and connected to the computer by a pair of twisted wires. The mouse is generally plugged into the back of system unit, into the motherboard, with a green PS/2 connector. Some mice are connected to PC via USB port or wireless port. Figure 5.2.5 shows a mouse with two buttons and a wheel.



Figure 5.2.5: A mouse

There are three basic types of mice:

* ***Mechanical mouse***: It has a rubber or metal ball on its underside that can roll in all directions. Mechanical sensors detect the direction the ball is rolling and move the screen pointer accordingly.
* ***Opto-mechanical mouse***: It is same as a mechanical mouse, but uses optical sensors to detect motion of the ball.
* ***Optical mouse***: It uses a laser to detect the mouse's movement. Optical mice have no mechanical moving parts. They respond more quickly and precisely than mechanical and optomechanical mice, but they are also more expensive.

**Light Pen:** The earliest pointing device is the light pen. This device is placed close to a screen or a monitor and turned on. A photo sensor inside the light pen detects the scanning beam sweeping back and forth across the screen. Accompanying circuitry converts the pen’s reading into the position of the pen on the screen. Light pens are used to see the items from a list or menu displayed on the screen and to draw graphic display on the screen.

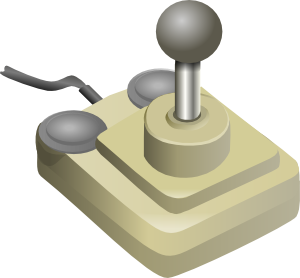
**Digitized Pad:** A digitizer pad looks like a graph pad with a pointer. It functions like a light pen on a display screen except that the pad is mounted horizontally. As the pointer is moved on the pad, the corresponding point on the screen is illuminated. The digitizer pad is useful in converting graphic input, such as charts, graphs and blueprints into patterns that can be stored by the computer.

**Drawing Tablet:** A drawing tablet is similar to a white board, except a special pen is used to write on it and it is connected to the computer as shown in Figure 5.2.6.  Then the word or image drawn can be saved on the computer.



***Figure 5.2.6: Drawing Tablet***

**Joystick and Trackball:** A joystick is input device consisting of a handheld stick that pivots about one end and transmits its angle in two or three dimensions to a computer. Most joysticks are two-dimensional, having two axes of movement (similar to a mouse), but three-dimensional joysticks do exist. A trackball is similar in operation to the joystick. It uses a billiard-sized ball to position the cursor. Several keyboard manufacturers have integrated them into their keyboard. Figure 5.2.7 shows a Joystick.

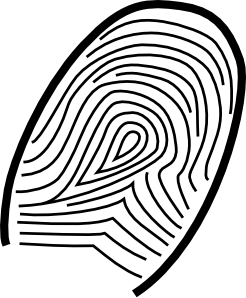


***Figure 5.2.7: Joystick***

**Touch Screen:** A touch-screen is an intuitive computer input device. It works by simply touching the display screen, either by a finger, or with a stylus. Computers with touch-screens have a smaller footprint, and can be mounted in smaller spaces; they have fewer movable parts, and can be sealed. Touch-screens may be built in, or added on. Add-on touch-screens are external frames with a clear see-through touch-screen which mounts on the monitor bezel and have a controller built into their frame. Built-in touch-screens are internal, heavy-duty touch-screens mounted directly on the CRT tube.

The touch-screen interface is the most simple, intuitive, and easiest to learn of all PC input devices and is fast becoming the interface of choice for a wide variety of applications, such as: public information systems, restaurant systems, customer self-service, control/automation systems etc.

**Fingerprint Recognition:** Fingerprint recognition refers to the automated method of verifying a match between two human fingerprints. Fingerprints (Figure 5.2.8) are one of many forms of biometrics used to identify individuals and verify their identity.



***Figure 5.2.8: Fingerprint of thumb.***

**5.2.4 Scanning Devices**

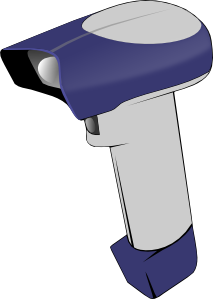
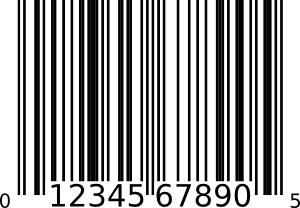
**Scanner:** A scanner is an acquisition peripheral for scanning documents, i.e. converting a paper document to a digital image. Figure 5.2.9 shows the diagram of a scanner. There are generally three types of scanners:

1. Flat scanners can scan a document by placing it flat against a glass panel. This is the most common type of scanner.
2. Hand scanners are smaller in size. These scanners must be moved manually (or semi-manually) in successive sections over the document in order to scan the whole document.
3. Sheet-fed scanners feed the document through a lighted slot in order to scan them, similar to fax machines. This type of scanner is increasingly built into machines such as multi-function printers.



Figure 5.2.9: A scanner

**Barcode reader:** A barcode reader is an electronic device for reading printed barcodes as shown in Figure 5.2.10. Like a flatbed scanner, it consists of a light source, a lens and a light sensor translating optical impulses into electrical ones. Additionally, nearly all barcode readers contain decoder circuitry analyzing the barcode's image data provided by the sensor and sending the barcode's content to the scanner's output port.



***Figure 5.2.10: A barcode and a barcode reader***

**5.2.5 Other Input devices**

**Digital camera:** A digital camera takes still photographs or video or both digitally by recording images via an electronic image sensor. Most of the cameras available in the market are digital. Digital cameras display images on a screen immediately after they are recorded, storing thousands of images on a single small memory device, and deleting images to free storage space.

Digital cameras are optical systems that work like the film cameras typically using a lens with a variable diaphragm to focus light onto an image pickup device. The diaphragm and shutter admit the correct amount of light to the imager, just as with film but the image pickup device is electronic rather than chemical.

Digital cameras are incorporated into many devices ranging from PDAs and mobile phones to vehicles. The Hubble Space Telescope and other astronomical devices are essentially specialized digital cameras. Figure 5.2.11 shows a digital camera.



***Figure 5.2.11: A digital camera***

**Webcam:** A webcam is a video camera which feeds its images in real time to a computer or computer network, often via USB, Ethernet or Wi-Fi. Their most popular use is the establishment of video links, permitting computers to act as videophones or videoconference stations. This common use as a video camera for the World Wide Web gave the webcam its name. Other popular uses include security surveillance and computer vision.

**Microphone:** A microphone, as shown in Figure 5.2.11, is an acoustic-to-electric transducer that converts sound into an electrical signal. It is used in computers for recording voice, speech recognition, VoIP.



***Figure 5.2.12:*** Microphone

Microphone also makes PC useful for audio conference over internet. It is also used for translating spoken word into text. Speak recognition is a technique of translating voice to text. Using it, one can detect to the computer instead of typing and one can control the computer with simple command.

**5.2.6 Key points**

* Keyboard is an input device that is used to enter data to a computer.
* There are at least four ways to connect a keyboard to a computer. These are Serial, PS/2, USB and Cordless (wireless).
* American National Standards Institute (ANSI) defines Magnetic Ink Character Recognition (MICR), which is the common machine language specification for the paper-based payment transfer system.
* An optical mark reader (OMR) is a device that can read human-marked data that have been placed in specific places on a form or card. The OMR is used mainly for survey and tests.
* Optical character recognition (OCR) device translates scanned images of handwritten, typewritten or printed text into machine-encoded text.
* A smart card reader is an electronic device that reads smart cards which is a microchip or possibly an embedded integrated circuit (IC).
* The mouse is a pointing device used to move a cursor on the screen and allowing objects to be selected, moved and manipulated using the buttons.
* The earliest pointing device is the light pen. This device is placed close to a screen or a monitor and turned on.
* A digitizer pad looks like a graph pad with a pointer. It functions like a light pen on a display screen except that the pad is mounted horizontally.
* A drawing tablet is similar to a white board, except a special pen is used to write on it and it is connected to the computer.
* A joystick is input device consisting of a handheld stick that pivots about one end and transmits its angle in two or three dimensions to a computer.
* A scanner is an acquisition peripheral for scanning documents, i.e. converting a paper document to a digital image.
* A barcode reader is an electronic device for reading printed barcodes as shown in Figure 5.2.10. Like a flatbed scanner, it consists of a light source, a lens and a light sensor translating optical impulses into electrical ones.
* A digital camera takes still photographs or video or both digitally by recording images via an electronic image sensor.
* A webcam is a video camera which feeds its images in real time to a computer or computer network, often via USB, Ethernet or Wi-Fi.

**5.2.7 Exercise**

**Multiple choice questions**

1. Which one the following looks like a graph pad with a pointer?
   1. Light pen
   2. Drawing table
   3. Drawing tablet
   4. Digitized Pad
2. Which one is the not an input device?
   1. Touch screen
   2. Joy stick
   3. Fingerprint recognizer
   4. Headphone
3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is the common machine language specification for the paper-based payment transfer system
   1. ANCI
   2. ANSI
   3. MICR
   4. MIRC

**Question for Short Answer**

1. What is the function of keyboard and mouse?
2. Distinguish between OMR and OCR.
3. What are the disadvantages of OCR.
4. What is the main application of OMR.
5. Draw the Optical character recognition process
6. How does a webcam differ from a digital camera.

**Analytical Question**

1. Describe different types of pointing devices.
2. Explain different types of scanning devices.
3. Distinguish different types of scanners.

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***Lesson 5.3***

***Output Devices***

**5.2.0 Objectives**

*On completion of this lesson you will know:*

* *CRT, LED, LCD and Plasma Monitors*
* *Different types of printers.*
* *Network printers and plotter*
* *Computer output microfilm*
* *Voice output system, projector, headphone*
* *Other peripheral devices*

**5.3.1 Monitors**

The monitor is the commonly used display device. There was an age when computer monitor uses cathode ray tube (CRT). The domination of CRTs is over today with the arrival of LCD, Plasma and LED monitors.

**Cathode ray tube monitor:** CRT monitor use glass vacuum tubes into which an electron gun emits a flow of electrons guided by an electrical field towards a screen covered in small phosphorescent elements as shown in Figure 5.3.1. In a CRT Monitor, the electron gun is made up of a cathode, a negatively charged metallic electrode, and one or more anodes (positively charged electrodes). The cathode emits the electrons attracted by the anode. The anode acts as an accelerator and concentrator for the electrons, forming a flow of electrons aimed at the screen. A magnetic field guides the electrons from left to right and from top to bottom. It is created with two electrified X and Y plates (called deflectors) which send the flow horizontally and vertically, respectively. The screen is covered with a fine layer of phosphorescent elements, called phosphors, which emit light by excitation when electrons strike them, creating a lit-up dot called a pixel. Activating the magnetic field causes the electrons to follow a scan pattern, going from left to right and then down to the next row once they reach the end. The human eye cannot see this scanning due to persistence of vision.



***Figure 5.3.1: CRT Monitor***

For colour monitors, three electron beams coming from three different cathodes strike at a point and sees a single colour made up of red, green, and blue (RGB). Three points of colour are called a triad (or dot trio).

**Flat-screen monitors:** Flat-screen monitors (also called FPDs for Flat panel displays) are becoming more and more widespread, as they take up less space, are less heavy than traditional CRT monitors, uses less energy (lower than 10W, as opposed to 100W for CRT monitors) and emits less electromagnetic radiation. Figure 5.3.2 shows a flat-screen monitor.



***Figure 5.3.2: Flat-screen monitors***

**Liquid crystal displays (LCD):** It is based on a screen made up of two grooved transparent parallel plates, oriented at 90° to one another. The space between them holds a thin layer of liquid containing certain molecules, called liquid crystals, which change direction when they are exposed to electrical current. The first plate acts as a polarizing filter, i.e., only those light components whose oscillation is parallel to the grooves pass through it. In the absence of electrical current, the light is blocked by the second plate, which acts as a perpendicular polarizing filter. When powered, the crystals align one by one in the direction of the electric field, and can cross the second plate. By locally controlling the orientation of the crystals, it is possible to make pixels.

**Plasma screens:** Plasma technology, also called, Plasma Display Panel (PDP), is based on emitting light by exciting gases. The gas used in plasma screens is a mixture of argon (90%) and xenon (10%). Gas is contained within cells, each one corresponding to a pixel that corresponds to a row electrode and column electrode, which excite the gas within the cell. By modulating the voltage applied by the electrodes and the frequency of excitation upto 256 luminous values can be defined. The gas excited this way produces ultraviolet radiation which is invisible to the human eye. With blue, green, and red phosphors distributed among the cells, the ultraviolet radiation is converted into visible light, so that pixels, which is made up of 3 cells, can be displayed in up to 16 million colours (256×256×256).

Plasma technology can be used to create large-scale high-contrast screens, but plasma screens are still expensive. What's more, power consumption is more than 30 times higher than that for an LCD screen

**Light-emitting diode Screen**: Light-emitting diode (LED) is a [semiconductor](http://en.wikipedia.org/wiki/Semiconductor) light source.  When a light-emitting [diode](http://en.wikipedia.org/wiki/Semiconductor_diode) is forward-[biased](http://en.wikipedia.org/wiki/Voltage_bias) (switched on), [electrons](http://en.wikipedia.org/wiki/Electrons) are able to recombine with [electron holes](http://en.wikipedia.org/wiki/Electron_hole) within the device, releasing energy in the form of [photons](http://en.wikipedia.org/wiki/Photon). This effect is called [electroluminescence](http://en.wikipedia.org/wiki/Electroluminescence) and the [color](http://en.wikipedia.org/wiki/Color) of the light is determined by the [energy gap](http://en.wikipedia.org/wiki/Energy_gap) of the semiconductor. Video LED display panel is in fact a large television set which is made of separate LED modules into video screens of different sizes and shapes. Table: 5.3.1 shows contrast and compare between the different types of computer monitors

**Table: 5.3.1 Contrast and compare between the different types of computer monitors**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Factors | CRT | LCD Display Panel | LED Display Panel | Plasma Display Panel |
| **Viewing angle** | Excellent viewing angle | Limited viewing angle | Excellent viewing angle. | Excellent viewing angle |
| **Size** | bigger and bulkier | Smaller | Smaller | Smaller than CRT |
| **Power consumption** | Relatively high power consumption at high brightness and contrast levels and fast scan rates. | On average, 50-70% less energy is consumed than CRT monitors. | Increased power consumption when displaying white color | Variable power consumption (dimmer picture draws less power) though still higher than most LCD TVs in most situations |
| **Geometric distortion** | It is caused by variable beam travel distances distortion in most high-end displays. | No geometric distortion. | No geometric distortion. | No geometric distortion |
| **Ghosting and smearing artifacts** | No ghosting and smearing artifacts during fast motion due to sub-milliseconds response time | Smearing and ghosting artifacts on moving objects caused by slow response times (>8 ms). | No ghosting and smearing artifacts | Millisecond response time |
| **Weight** | Large size and weight, especially for bigger screens | Very light weight | Very light weight | Highly scalable, with less weight gain per increase in size |
| **Black level** | Excellent black level | Black levels may appear unacceptably bright due to the fact that individual liquid crystals cannot completely block all light from passing through. | Excellent black level | High contrast ratios (10,000:1 static or greater) excellent color, and low black level. |
| **Flicker** | Produces noticeable flicker at low refresh rates although all recent CRT monitors have sufficiently fast refresh rates | The possible ability to have little or no flicker depending on backlight technology. | no flicker | Image flicker due to being phosphor-based though modern plasma displays make this effect less noticeable. |
| **Environmental hazard** | CRTs, may contain contaminants such as lead, cadmium, beryllium, or brominated flame retardants | Mercury is used which is hazardous to environment. | Lot more eco-friendly because mercury is not used and consumed very small power. | Less environmental impact. But it consumed more electricity than LCD and LED. |

**5.3.2 Printers**

The printer is a peripheral that allows making a print-out of computer data on papers. There are several printer technologies, the most common of which are briefly described below:

**Daisy Wheel Printer:** Daisy wheel printers are based on typewriters. A matrix in the shape of a daisy contains "petals" that each has one raised character. To print the text, a ribbon of ink is placed between the daisy and the sheet of paper. When the matrix hits the ribbon it leaves ink on paper in the shape of the character on the petal. These printers are obsolete because they are extremely noisy and very slow.

**Dot-Matrix Printer:** The dot-matrix printer (also called a matrix printer or an impact printer) allows to print documents on paper. The head is made up of tiny metal pins, driven by electromagnets, which strike a carbon ribbon called an "inked ribbon", located between the head and the paper. The carbon ribbon scrolls so that there is always ink on it. At the end of each line, a roller makes the sheet advance. The most recent dot-matrix printers are equipped with 24-needle printer heads, which allows them to print with a resolution of 216 dpi (dots per inch).

**Inkjet Printer and Bubble Jet Printer:** The inkjet printer technology was originally invented by Canon Company. It is based on the principle that a heated fluid produces bubbles. The researcher who discovered this had accidentally brought a syringe filled with ink into contact with a soldering iron. This created a bubble in the syringe that made the ink in the syringe shoot out.

Today's printer heads are made up of several nozzles (up to 256), equivalent to several syringes, which are heated up to between 300 and 400°C several times per second. Each nozzle produces a tiny bubble that ejects an extremely fine droplet as shown in Figure 5.3.3. The vacuum caused by the decrease in pressure creates a new bubble.



***Figure 5.3.3: An ink bubble created in a bubble jet printer***

Inkjet printers (Figure 5.3.4) use nozzles that have their own built-in heating element. Thermal technology is used here. Bubble jet printers use nozzles that have piezoelectric technology. Each nozzle works with a piezoelectric crystal that changes shape when excited by its resonance frequency and ejects an ink bubble.

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***Figure 5.3.4: An inkjet printer***

**Laser Printers:** Laser printers are another popular alternative to legacy impact printing. Laser printers are known for their high volume output and low cost-per-page. The other advantages of laser printers are:

* Very high speed
* Low noise level
* Low maintenance requirement
* Very high image quality
* Excellent graphics capabilities

Laser printers are often deployed in enterprises as a workgroup or departmental print center, where performance, durability, and output requirements are a priority (Figure 5.3.5). Because laser printers service these needs so readily, the technology is widely regarded as the workhorse of enterprise printing.

Laser printers share much of the same technologies as photocopiers. Rollers pull a sheet of paper from a paper tray and through a charge roller, which gives the paper an electrostatic charge. At the same time, a printing drum is given the opposite charge. The surface of the drum is then scanned by a laser, discharging the drum's surface and leaving only those points corresponding to the desired text and image with a charge. This charge is then used to force toner to adhere to the drum's surface.

The paper and drum are then brought into contact; their differing charges cause the toner to adhere to the paper. Finally, the paper travels between fusing rollers, which heat the paper and melt the toner, fusing it on the paper's surface.



***Figure 5.3.5: Laser printer***

Color laser printers aim to combine the best features of laser and inkjet technology into a multi-purpose printer package. The technology is based on traditional monochrome laser printing, but uses additional components to create color images and documents. Instead of using black toner only, color laser printers use a CMYK toner combination.

**Thermal Wax Printer**: Thermal wax printer is used for presentation graphics and handout. They operate with a ribbon coated with panels of coloured wax that melts and adheres to plain paper as coloured dots when passed over a focused heat source. It is also used for poster and book covers.

**Dye Sublimation Printer**: Dye sublimation printer is mainly used for realistic quality and colour photo image. They operate with a ribbon containing with panels of colour is moved across a focused head source capable of subtle thermal variation. The variations in colour are related to the applied heat intensity. The heated dye evaporates from the ribbon and diffuses on special coated paper or another material where they form aras of different colour.

**Plotter:** A plotter draws pictures on paper as shown in Figure 5.3.6. It differs from a printer in that it draws lines using a pen. As a result, they can produce continuous lines, whereas printers can only simulate lines by printing a closely spaced series of dots. Multicolor plotters use different-colored pens to draw different colors. In general, plotters are considerably more expensive than printers. They are used in engineering applications where precision is mandatory.



***Figure 5.3.6: Plotter***

**3D Printer:** A 3D printer is a special type of industrial-robot that is able to make a 3D solid object of virtually any shape from a computer control digital model. It uses an additive process where successive layers of material are laid down in different shapes. Traditional machining techniques rely on the removal of material by methods such as cutting or drilling, also called subtractive process, whereas 3D printing is an additive process. The 3D printing technology is used for prototyping and distributed manufacturing with applications in architecture, construction, industrial design, automotive, aerospace, military, engineering, civil engineering, dental and medical industries, biotech (human tissue replacement), fashion, footwear, jewelry, eyewear, education, geographic information systems, food, and many other fields.

**Network versus Local Printers:**

A local printer is attached to every workstation. Depending on organizational needs, it is unnecessary to assign one printer to each member (or workstation) of an organization. Printer manufacturers have addressed this need by developing workgroup printers. These machines are usually durable, fast, and have long-life. Workgroup printers usually are attached to a print server (as shown in Figure 5.3.7), a standalone device (such as a reconfigured workstation) that handles print jobs and routes output to the proper printer, when available. More recent departmental printers include built-in or add-on network interfaces that eliminate the need for a dedicated print server.



**Figure 5.3.7**: Network Printer

**Microfilm Devices:** Computer output microfilm (COM) devices convert computer output to a human readable form stored on rolls of microfilm or as microfilm frames stored on cards called microfiche. It is one of the fastest computer output techniques, which is usually faster ( to over lines per minute) than the fastest impact printer. A single roll of microfilm can store approximately 2000 frames. It costs less than half the cost to print the same amount of data on paper.

Because of high cost of COM equipment, it is generally practical for larger businesses or industries generating several thousand documents per day. COM devices are commonly used in libraries, mail-order concerns, defense installations, government agencies and for similar large operation.

**Projector:** Projector is an output device that can take the display of a computer screen and projects a large version of it on a flat surface as shown in Figure 5.3.8. It is often used in meetings and presentations so that everyone in the room can view the presentation.



***Figure 5.3.8: A projector screen and a projector***

**5.3.3 Voice output system**

**Computer speaker:** Computer speaker refers to external speaker of a computer (Figure 5.3.9). They are pluged into a 3.5 mm green colour stereo jack-plug. There are some speakers which are powered by the USB port. More sophisticated speakers can have a 'subwoofer' unit which enhances bass output, and these units usually include power amplifiers both for the bass speaker, and the small 'satellite' speakers. Laptops come with integrated speakers. Restricted space available in laptops means these speakers usually produce low-quality sound.

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***Figure 5.3.9: Computer speaker***

**Headphones:** Headphones consist of a pair of small loudspeakers (Figure 5.3.10), or less commonly a single speaker, held close to a user's ears. These are connected to a signal source such as radio, CD player or portable media player via audio amplifier. They are also known as stereo-phones, headsets, earphones or ear-buds.



***Figure 5.3.10: Headphone***

**5.3.4 Other peripheral devices**

**Terminal:** A terminal is a popular input/output device or high-end microcomputer which is used for bidirectional communication with a CPU or with other terminals connected to a local area network and run multi-user operating systems. With the aid of a terminal a user can access computer around the world. Terminals are called workstations which allow a user to interact with a computer. It uses a keyboard to enter data and a monitor to display data. Because data must be keyed into this device one character at a time, the possibility of error is high and the data transmission rate is very low, thus limiting the use of terminals to small-volume input and inquires only. Some of the functions that can be performed using terminals are described below

***Messaging*:** It is the transmission of information from one terminal to one or more remote terminals.

***Data collection***: Data are received by terminals and recorded on secondary storage media for subsequent processing. This eliminates needs to record information on a source document and then to key the information from the source document into a computer.

Inquiry or transaction processing: Data stored in central data files can be accessed from remote terminals for updating or to determine answers to inquiries about information stored in these files. The system employed by most airlines to maintain and update flight information is an example of such a function.

***Remote job processing***: Programs can be received from remote terminals directly to a CPU for processing. After execution, the results can be transmitted back to the terminal or to other terminals for output.

***Graphic display and design:*** Data can be displayed in graphic form, and can also be manipulated and modified. Interactive graphic displays, from simple video games displayed on a television set to sophisticate computerized system; provide complex designs and three-dimensional displays. In general there are three basic types of terminals, these are

1. Dumb terminal: It has no built-in data processing capabilities and serves only to send and receive data,
2. Smart terminal: It has limited data processing capabilities, and
3. Intelligent terminal: It has substantial data processing capabilities due to inbuilt processor and memory.

**Vision systems:** A vision system utilizes a camera, digitizer, computer and a technique known as image processing. Image processing is concerned with digitizing and storing of computer-processed images and with pattern recognition. Familiar examples of computer-processed images are: computer generated digitized portraits at amusement parks, computer-produced special effects in movies, digitized images of Jupiter and Saturn beamed from image processors of space craft to earth etc. All of these examples have one thing in common, that is digitizing an image. In a visual system, all images that must be recognized or interpreted are digitized and stored in a database. Only after the database has been established, the visual system can be applied to pattern recognition. Pattern recognition, the process of interpreted images, begins when the system digitizes the image of the object to be interpreted. The digitized image is then compared to those in the database to determine a probable match. As it is unlikely that a perfect match will be achieved, there is always a small possibility of error.

**Modem:** Modem is the peripheral used to transfer information between several computers over a wired transmission medium (telephone lines) as shown in Figure 5.3.11. Computers operate digitally using binary language (i.e., binary 1 or 0). Modem, but twisted pair media can handle analogue signal only. Modem converts binary data into analog signals. Thus, a modem modulates digital information on analogue waves. In the opposite direction, it demodulates analogue data in order to convert them into digital data. The word "modem" is an acronym for "MOdulate/DEModulate".



***Figure 5.3.11: Modem***

A modem's transmission speed is generally expressed in bauds, in tribute to Emile **Baud**ot (11 September 1845 - 28 March 1903), a famous French engineer who worked in the area of telecommunications. This unit of transmission speed characterizes the frequency of (de)modulation, i.e. the number of times the modem makes the signal change status per second.

**5.3.5 Key Point**

* The monitor is the commonly used display device.
* Old style monitors use CRT, which are glass vacuum tubes into which an electron gun emits a flow of electrons guided by an electrical field towards a screen covered in small phosphorescent elements.
* For colour CRT monitors, three electron beams coming from three different cathodes strike at a point and processes a single colour made up of red, green, and blue (RGB). Three points of colour are called a triad (or dot trio).
* In plasma monitor, variable power consumption (dimmer picture draws less power) though still higher than most LCD monitor’s in most situations.
* In CRT, geometric distortion is caused by variable beam travel distances but almost no distortion in most high-end displays.
* There is not geometric distortion in LED, LCD and plasma monitors.
* In LCD, black levels may appear unacceptably bright due to the fact that individual liquid crystals cannot completely block all light from passing through.
* The LED monitors is more eco-friendly because mercury is not used and consume very small power.
* Daisy wheel printers are based on typewriters.
* In dot matrix printer, the head is made up of tiny metal pins, driven by electromagnets.
* Inkjet printer is based on the principle that a heated fluid produces bubbles.
* A plotter draws pictures on paper. It differs from a printer in that it draws lines using a pen.
* Computer output microfilm (COM) devices convert computer output to a human readable form stored on rolls of microfilm or as microfilm frames stored on cards called microfiche.
* A terminal is a popular input/output device or high-end microcomputer which is used for bidirectional communication with a CPU or with other terminals connected to a local area network and run multi-user operating systems.
* Speech recognition devices systems contain a database of stored voice patterns.
* A vision system utilizes a camera, digitizer, computer and a technique known as image processing. Image processing is concerned with digitizing and storing of computer-processed images and with pattern recognition.
* Modem is the peripheral used to transfer information between several computers over a wired transmission medium (telephone lines)

**5.3.6 Exercise**

**Multiple choice questions**

1. Which one the following is more eco-friendly?
   1. LED TV
   2. LCD TV
   3. CRT
   4. Plasma
2. Inkjet printer is based on the principle that a\_\_\_\_\_\_\_\_\_\_\_\_.
   1. heated metal pin produces ink to vapor
   2. heated fluid produces bubbles
   3. heated paper produces permanent mark of ink
   4. none
3. A terminal is a popular \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ device.
   1. input
   2. output
   3. input/output
   4. none

**Review Questions**

1. What is the function of keyboard and mouse?
2. Distinguish between Network and local printer.
3. What are the applications of a plotter?
4. List advantages of a LASER printer.
5. Why are microfilm devices required?
6. What are the three basic types of terminals?
7. Write down applications of a projector.

**Analytical Questions**

1. Distinguish between different types of computer monitors.
2. Explain different types of printers.
3. What is the principle of operation of a MODEM?
4. Explain speech recognition and voice response devices.