Unit 4: Input and Output Devices

Introduction

The unit 4 presents the information of input and output devices. A number of input/output devices are used with many types of microcomputers. Many of these are less complex versions of I/O devices that have been available for larger computer systems. The principal difference is that because they are intended for use with microcomputers, they are significantly slower and substantially cheaper. Few of these devices are discussed in this unit.

Lesson 1: Input Devices

1.1 Learning Objectives

On completion of this lesson you will be able to:

- understand the functions of input devices
- know different types of input devices.

1.2 Keyboards

Full-stroke keyboard, enhanced keyboard.

The most common of all input devices is the keyboard. Several versions of keyboards are available. The best and most expensive of these is the full-stroke keyboard. This is ideal for word processing and other volume data and program entry activities. This type of keyboard is available with most mainframe computer terminals or the expensive microcomputer systems.

Some popular microcomputers offer enhanced keyboard for easy entry of numbers. This is accomplished with a smaller group of keys known as a numeric keypad at the right of the keyboard. These keys generally consist of the digits, a decimal point, a negative sign, and an ENTER key. This type of keyboard is ideal for accounting operations, which require a large volume of numbers to be entered.

Keyboards generally utilize integrated circuits to perform essential functions, such as determining the combination of 1s and 0s, or binary code, to send to the CPU, corresponding to each key depressed, switching between shifted and nonshifted keys, repeating a key code if a key is held down for a prolonged period of time, and temporarily storing or "buffering" input when keys are typed too fast.

QWERTY arrangement

The keyboard arrangement provided as standard on most keyboards is the QWERTY arrangement, named for the six letters beginning the row at the top left of the keyboard (Figure 4.1). This arrangement was chosen intentionally to slow expert typists, since those who typed too fast would cause the keys on a mechanical typewriter to jam. Slowing down the typist was accomplished by scattering the most used around the keyboard, making frequently used combinations of letters awkward and slower to type. This QWERTY keyboard arrangement has been used for nearly a century.

Dvorak simplified keyboard

The Dvorak Simplified Keyboard (DSK) arrangement, designed in 1932 by August Dvorak, is the result of extensive ergonomic studies. Dvorak noted that with the QWERTY keyboard arrangement, typists used the weakest fourth and fifth fingers of their left hand a large proportion of the time. Thus, Dvorak rearranged the keyboard so that the five more frequently used vowels (a, o, e, u, and i) and the five most frequently used consonants (d, h, t, n, and s) were positioned on the home row where the fingers of the left and right hands rest, respectively (Figure 4.2). Thus, 70 percent of the typing is done on the home row. He then placed the next most frequently used characters in the row above the home row and the least frequently used characters in the row below the home row. This resulted in a reduction of finger movement of approximately 80 percent and overall, an increase in productivity of nearly 40 percent.

Expert typists and word processors generally agree that using the Dvorak arrangement increases productivity while simultaneously decreasing fatigue. The world's fastest typing speed, nearly 200 words per minute, was achieved on a Dvorak keyboard. Despite these improvements the QWERTY keyboard arrangements is still the most common because of the difficulty of overcoming inertia and retraining.

In the mean while, microcomputer manufacturers and software vendors are producing software that will convert your keyboard from QWERTY to Dvorak, and back again at will. To date, larger computer systems employ the traditional QWERTY arrangement only.

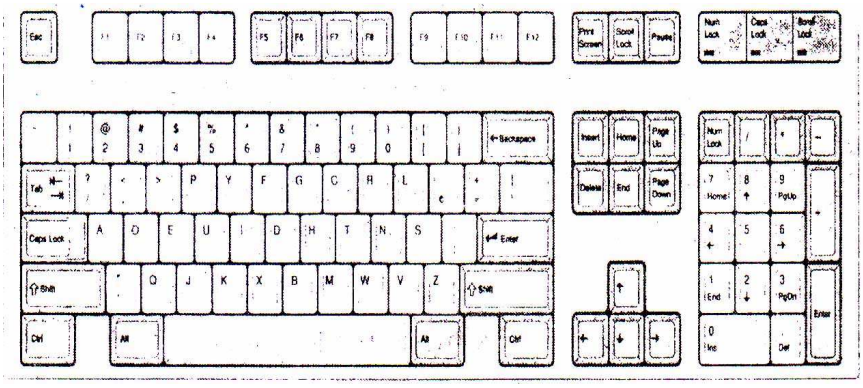


Figure 4.1 QWERTY Keyboard.

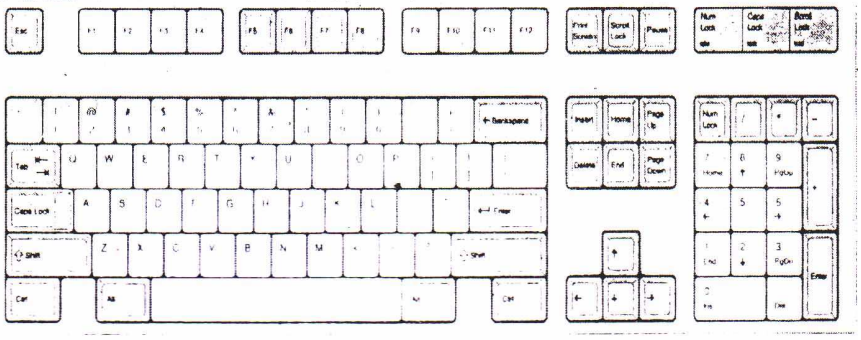


Figure 4.2: Dvorak Keyboard.

1.3 Other Input Devices

Punched Card

Punched card

The punched card has served as an input medium to automated computational devices. It has undergone little or no change since that time, and most companies have phased out and replaced it with the more efficient data entry media. Among the punched card devices still in use is the punched card reader. The reading of punched cards takes place at speeds ranging from hundred fifty to more than two thousand five hundred cards per minute.

Key-to-Tape and Key-to-Disk Systems

In a key-to-tape system, data entered at a keyboard are recorded directly on magnetic tape. The magnetic tape used is similar to the tape cartridge or cassette used with home recorders. Accuracy is verified by placing the recording tape into a magnetic tape verifier and having the original data retyped. Magnetic tape encoders and verifiers are generally housed in the same physical unit. Errors detected are corrected simply by erasing the mistakes and substituting the correct character(s).

Character Readers

Character Readers

A character reader is capable of accepting printed or typed characters from source documents and converting these data into a computer-acceptable code. Currently available high-speed character readers are capable of reading source documents at rates of up to several thousand documents per minute and are costly. The three basic types of character readers are magnetic-ink, optical mark, and optical character readers.

Magnetic-ink Character Readers

MICR

Magnetic-Ink Character Recognition (MICR) was developed by the Stanford Research Institute for use by the world's largest bank, the Bank of America. This system can read data prerecorded on checks and deposit slips with a special ferrite-impregnated ink. The magnetized characters can be read and interpreted by MICR equipment.

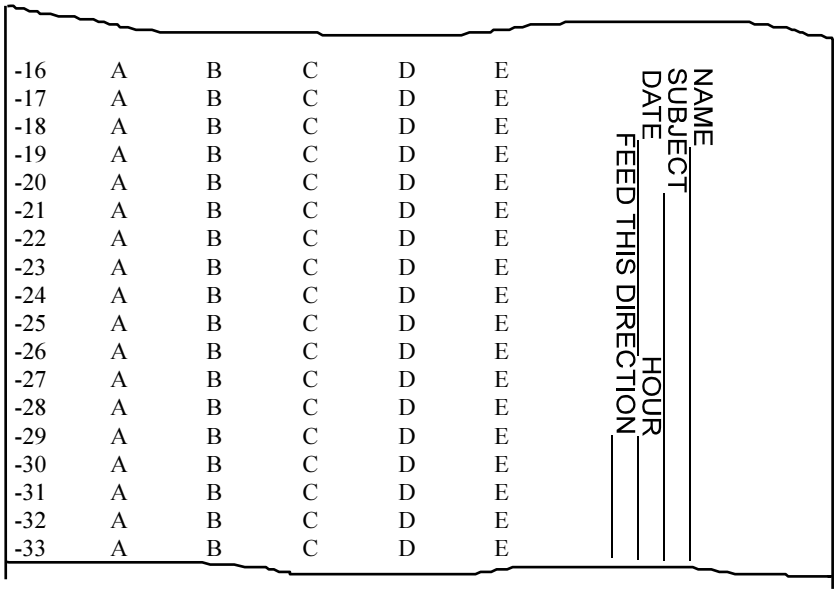


Figure 4.3 Portion of a special-purpose optical mark form.

Optical Mark Readers

Optical Mark Readers(OMR)

Optical mark readers (OMR) optically read marks on carefully printed forms. Optical mark forms are relatively expensive, as they must be printed with exact tolerances so that the marks will up under the optical sensing devices when read (Figure 4.3). The most popular use of such devices is optical character readers for scoring examinations in educational institutions.

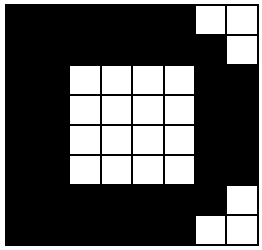
Optical Character Readers (OCR)

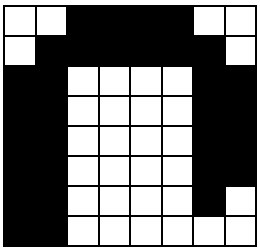
Optical Character Recognition (OCR).

Optical character recognition (OCR) devices can convert data from source documents to a machine-recognizable form. Current applications of optical scanning include billing, insurance premium notices, and charge sales invoices. At present, on OCR device can reliably read and interpret script or handwriting. However, some can read handwriting provided that certain general guidelines are observed when the data are written. Generally, optical character readers are limited with respect to hand-written characters and can only read handwritten digits and some symbols. Many OCR devices are available for the reading of typed characters, including digits, letters and some special characters. Not all printed characters can be read reliably on OCR readers. Generally, each reader is capable of reading only selected character styles.

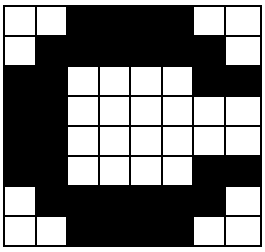
Even if the character style and spacing are acceptable, errors can result from reading a character that is not written perfectly. To reduce such errors, OCR devices generally compare the pattern read with the patterns to all acceptable character. The read character is assumed to be the

character whose stored pattern most closely matches the read pattern. This process is shown in Figure 4.4.

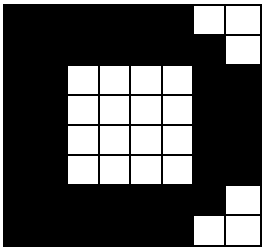




A 18 Discrepancies



C 10 Discrepancies



D 0 Discrepancies

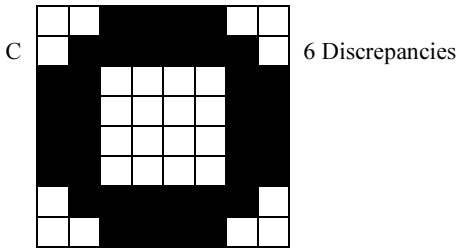


Figure 4.4: Character reads compare the digitized matrix of an unknown character against a stored set of templates.

Because of the high cost of OCR devices, they are uneconomic unless a substantial number of documents are to be processed each day.

CD, Web camera, disk drive, ATM, Scanner and bar code scanner can all be used as input devices.

Pointing Systems

Computer users frequently find it easier to point to something on a screen or at an item of text or graphical material they are entering into the computer, A number of devices are available to assist in fulfilling this need.

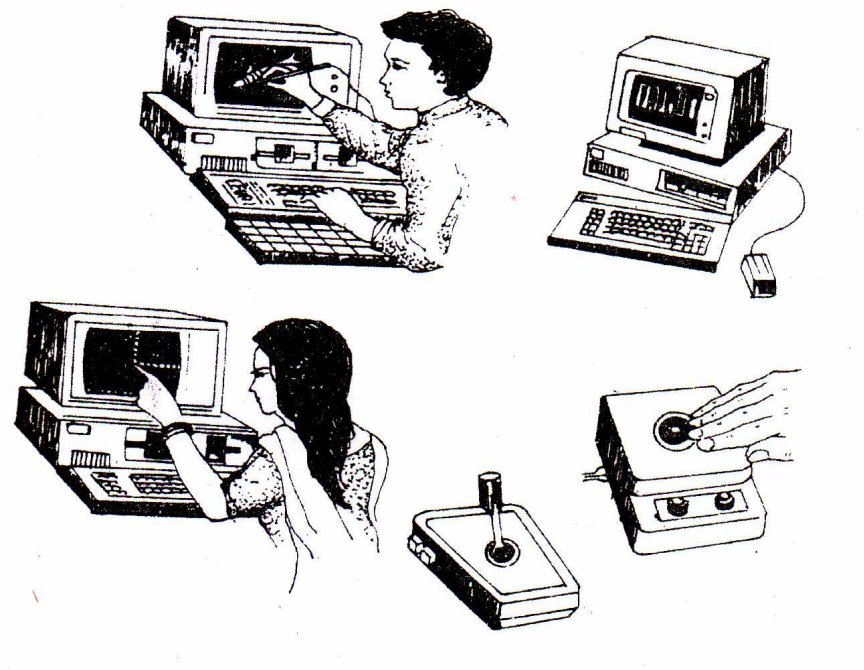


Figure 4.5 : Various pointing input devices.

Light Pen

Light Pen

The earliest pointing device is the light pen. This device is placed close to a screen or 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 select items from a list or menu displayed on the screen. Light pens are used to select items from a list or menu displayed on the screen and to draw graphic displays on the video screen.

Digitizer Pad

Digitizer Pad

A digitized 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 digitized pad is useful in converting graphic input, such as charts, graphs, and blueprints into patterns that can be manipulated and stored by the computer.

Mouse

Mouse

A mouse is a hand-movable device that controls the position of the cursor on a screen. It has a box with buttons on the top and a ball on the bottom. The box is placed on a flat surface, with the user's hand over it. The ball's movement on the surface causes the cursor to move.

Joystick and Trackball

Joystick and Trackball

Joysticks are used with video games for user input. These devices may also be used to move the cursor around a screen to facilitate input to a graphical display. 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 directly into their keyboards.

Touchscreen

Touchscreen

Touchscreen detects the touch of a human finger. One popular technique used to detect the touch of a finger utilizes infrared light beams. In this technique, infrared light beams shine horizontally and vertically on the face of the screen. A pointing finger interrupts both horizontal and vertical beams, pointing its exact location.

Pen drive

A pen drive is another name for a USB flash drive. Other names are flash drive. USB flash drive, Thumb drive, etc. They are devices that allow storage of computer files that you can remove and take from computer to computer. The price of the driver is determined by the size of its memory measured in megabytes or gigabytes. While 128 megabyte drivers used to be considered large, current pen drivers sizes can reach 1,2,4 or more gigabytes. The drivers inserted in the computers USB ports and are automatically recognized on PC operating systems beyond Windows 98 (which needs a separate installation of drivers). Pen drives can also have full blown application on them which are written in what is called U3 compatible software.

Figure 4.6 : A Pen Drive.

Scanner

In computing an **image scanner** often abbreviated to just **scanner** is a device that optically scans images, printed text, handwriting, or an object, and converts it to a digital image. Common examples found in offices are variations of the desktop (or flatbed) scanner where the document is placed on a glass window for scanning. Hand-held scanners, Where the device is moved by hand , have evolved from text scanning "wands" to 3D scanners used for industrial design, reverse engineering, test and measurement, orthotics, gaming and other applications Mechanically driven scanner that move the document are typically used for large-format documents, where a flatbed design would be impractical.

Figure 4.7 : Scanner.

CD-ROM

Pronounced *see-dee-rom*. Short for Compact Disc-Read-only Memory, a type of optical disk capable of shorting large amounts of data up to 1GB, although the most common size is 650 MB (megabyte). A single CD-ROM has the storage capacity to 700 floppy disks, enough memory to store about 300,000 text pages. CD-ROMs are stamped by the vendor, and once stamped, they cannot be erased and filled with new data. To read a CD, you need a CD-ROM player. All CD-ROMs comform to a standard size and format, so you can load any type of CD-ROM into any CD-ROM player. In addition, CD-ROM players are capable of playing audio CDs, which share the same technology. CD-ROMs are particularly well-suited to information that requires large storage capacity. This includes large software applications that support color, graphics, sound, and especially video and are well suitable for tutoring,

Figure 4.8 : A CD.

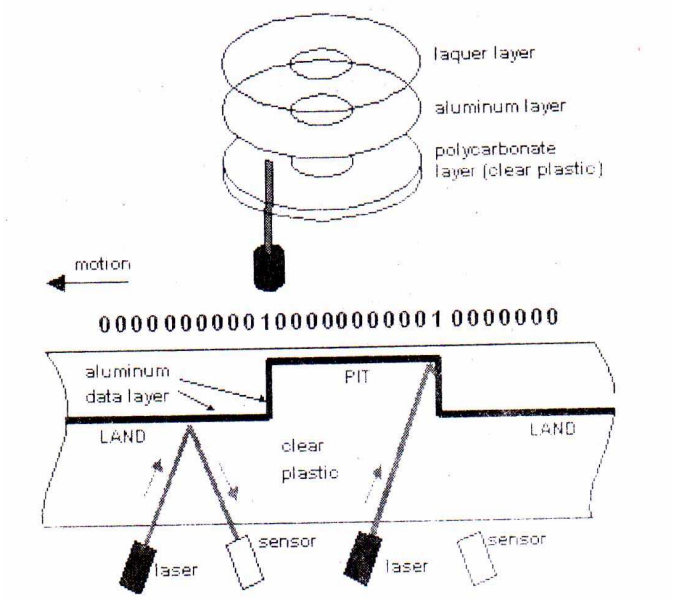


Figure 4.9 : Composition of a CD.

1.4 Exercise

1. Multiple choice questions

a. Increase in productivity using Dvorak simplified keyboard is nearly

(i) 60 percent
(ii) 30 percent
(iii) 40 percent
(iv) 50 percent.

b. Which one is used for scoring examinations?

(i) MICR
(ii) OMR
(iii) OCR
(iv) none of them.

c. Which one is used with video games for user input?

(i) Touchscreen
(ii) Mouse
(iii) Digitize pad
(iv) Joystick.

d. Touchscreen is usually used to detect the touch of a

(i) Human finger
(ii) Pen
(iii) Wooden stick
(iv) none of them.

2. Questions for short answers

a. Briefly describe the advantages of Dvorak simplified keyboard.
b. What is the basic difference between OMR and OCR?
c. What is a mouse in computer system?
d. Write down the application of digitized pad and touchscreen.

3. Analytical questions

a. Describe the keyboard as input device.
b. Describe basic types of character readers.
c. Describe different pointing systems.

Lesson 2: Output Devices

2.1 Learning Objectives

On completion of this lesson you will be able to :

- understand functions and characteristic of output devices
- know different types of devices.

2.2 Monitors

It is the most commonly used display device. The monitor, utilizes a cathode ray tube (CRT). CRT monitors generally produce images by the raster-scan method. In this method, an electron beam varying in intensity, is moved back and forth horizontally across the face of the monitor. As the beam is directed to each spot on the phosphor-coated screen, it illuminates the spot in proportion to the voltage applied to the beam. Each spot represents a picture element or pixel. When the electron beam has scanned the entire screen and illuminated each pixel, one can see a complete image. The image that can be seen is the one traced on the retinas of eyes by the light beam. However, this image will fade unless it is refreshed. Thus, the electron beam must scan the screen very rapidly (a minimum of 60 times per second), so that the intensity of the image remains approximately the same and the screen does not appear to flicker.

CRT monitors generally produce images by the rasterscan method.

The screen resolution of a particular monitor is determined by the number of pixels that make up the screen. Monitors are currently available with 64,000 to more than 2 million pixels per screen. The greater the resolution of a monitor the greater the storage demand on the computer. This is because the image must be stored in memory before it can be displayed. Two techniques used to store computer images are: bit-mapped and character-addressable.

In a bit-mapped display, each pixel is uniquely addressable. Information must be stored for each pixel on the screen. This technique needs quite a large computer memory and provides the most detailed display. For graphical applications, such as CAD/CAM, this detail is essential. However, for applications such as word processing, a character-addressable display is appropriate. In a character addressable display, the screen is divided into character positions. Only the characters to be displayed are stored in memory. As each character is retrieved from memory, it is converted into a pattern of dots or pixels by a special character generator module.

Monochrome monitors display one colour. Colour monitors produce multi-colour images by combining the red, blue, and green colour in varying intensities.

Monochrome or colour: Some monitors display images in only one colour while others are capable of producing images in colours. Monochrome monitors use a single electron beam and display one colour, generally green, amber, or white, on a black background. The phosphor composition of the screen determines the colour. Colour monitors produce multi-colour images by combining the red, blue, and green colours in varying intensities. Each pixel is made up of three colour dots: red, blue, and green. It will appear to glow in different colours depending on the intensity of each individual dot in the pixel. Colour monitors are commonly referred to as RGB monitors since they employ three election beams, one for each colour. Colour monitors are categorized as CGA, EGA, VGA and SVGA depending on the resolution. CGA monitors provide the least resolution (approximately 300 × 200 Pixels) and SVGA monitors provide the greatest resolution (1000 × 800 pixels and greater).

A monitor requires an appropriate interface to communicate with a computer.

Monitor interface: A monitor requires an appropriate interface to communicate with a computer. For example, a colour graphics interface board is needed for a colour monitor. This interface will generally not work with a monochrome monitor and might even damage it. Dozens of monitor interface boards are available for use with microcomputers. A caution must be exercised to match the interface to both the monitor and the computer.

Some smaller microcomputer systems can be used with a standard television.

Using a television: Some smaller microcomputer systems can be used with a standard television. The basic difference between a monitor and a television set is that the resolution of a television is substantially less than that with a monitor. Also the television requires the use of a modulator to interface the computer output with the television. The modulator combines the separate audio and visual signals sent by the microcomputer into a single modulated signal as required by a television. Most inexpensive computer systems designed for use with a television set generally have a built-in modulator.

Flat-Panel Displays

For laptop computers more compact, low-power, durable monitors are used. A number of flat-panel display technologies are available for this. The most common are the plasma and liquid crystal displays.

Plasma displays.

Plasma displays: A plasma display consists of an ionized neon or argon gas (plasma) sealed between two glass plates. One plate encases a set of fine horizontal wires and the other a set of vertical wires. Pixels are formed by the intersections of the horizontal and vertical wires. A single pixel can be turned on by sending a current through its horizontal and vertical wires. This causes the gas between the wires to produce an

amber glow. The images produced by plasma displays are generally very clear, and not subject to the flicker. Plasma displays are generally more expensive than the CRT displays.

Liquid Crystal Displays

Liquid crystal displays: Liquid crystal displays (LCDs) have been used for several years in calculators and digital watches. A thin layer of a liquid crystal substance is suspended between two thin sheets of polarized glass and separated by a wire grid into tiny squares. As current is applied to the wires the liquid crystal substance within the square changes from clear to opaque or black. The thousands of clear and black squares produce patterns of characters.

The disadvantage of LCD displays is lack of brightness and resolution as compared to CRT and plasma displays. The quality of the LCD display depends on the surrounding light and the viewing angle. It is sharpest and clearest when viewed in brightness from the front.

2.3 Printers

The printer is the most common output device. It produces permanent visual record of the data output from a computer. It is capable of producing business reports and documents currently available. Printers are capable of printing from 150 to over 20,000 lines per minute, with each line having up to 150 characters. Thus, a maximum printing speeds of approximately 50,000 characters per second is possible.

Printer is the most common output device. It produces permanent visual record of the data output from a computer.

Printers print on plain paper or on specially prepared single-or multiple copy forms, such as invoices, stationery, labels, checks, bills and other special-purpose forms used in business and industry. They can print both text and graphics in black and white or in colour.

Printers can be subdivided into two broad categories, impact and non-impact. The impact printers are the most common.

2.4 Impact Printers

Impact Printers

In impact printers, printing occurs as a result of a hammer striking a character form and the character form in turn striking an inked ribbon, causing the ribbon to press an image of the character on paper.

Character printer devices print one character at a time at speeds of about 10 to 500 characters per second. The fastest of these printers is the wire or dot-matrix printer. It prints characters made up of a pattern of dots formed by the ends of small wires Figure 4.6 shows the letter "A" as printed with different densities. By extending certain wires beyond the

others, a dot pattern can be created that gives the appearance of numbers, letters or special characters.

Dotmatrix Printers

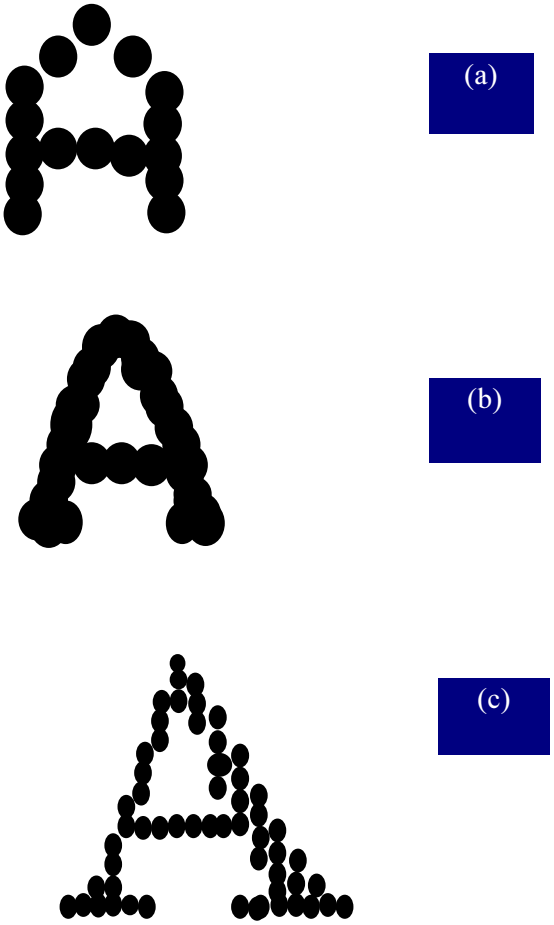


Figure 4.10: Dotmatrix printers form characters with an array of dots. Here the letter A is shown printed by (a) a 9-pin printer, (b) a 24-pin printer. (c) a 9-pin letter-quality dot-matrix printer capable of overlapped dot printing.

These extended wires are pressed against an inked ribbon to print the characters on the paper. Some slower and less expensive matrix printers

print a character as a series of columns each one dot wide. It can be used to print special character shapes that can be used with graphics.

For a typewriter-quality output, a special dot-matrix or daisy metal print element, similar in appearance to the arrangement of petals on a daisy flower. This element is rotated until the correct character is in position, and then pressed against an inked ribbon. The process is repeated for each character to be printed on a line. Typical for such printers range from 25 to 100 characters per second.

Impact character printers are the common output devices used with personal and small business microcomputer systems. They are significantly cheaper than the line printers.

Impact line printers, capable of printing a whole line at a time, employ print wheels or a moving chain or drum. The print-wheel printer consists of print wheels, each containing a full complement of digits and alphabetic characters in addition to a set of special characters. For printing, all print wheels rate positioned to represent the data to be printed on one line. They then impact simultaneously at a speed of about 150 lines per minute.

Impact line printers and the chain and drum printers are commonly used. As the print chain or drum revives, each character is printed as it comes into position. Up to 150 characters per line can be printed at speeds of up to 2,500 lines per minute. Impact line printers are used almost exclusively to support larger computer systems.

2.5 Nonimpact Printers

Nonimpact line printers, using laser, xerographic, electrostatic, or ink jet methods are the fastest printers. Before the development of the ink jet and laser printers, nonimpacts were not heavily used, for several reasons:

Nonimpact Printers

- Special and more expensive paper was required.
- Printed output was not as sharp or as clear as with impact printers.
- Only a single-part form can be printed at a time.
- Output could not be easily or satisfactorily copied on office copiers.

Electrostatic and xerographic printers place a pattern of the desired character on sensitized paper by means of an electric current or beam of light. The paper then passes through a powdery black substance called toner, which contains dry ink particles. The ink particles are attracted to

the exposed paper and the character becomes visible. These printers can print at speeds of from 3500 to 20,000 lines per minute.

Laser Printer

The laser printer form characters by projecting a laser beam of dot-matrix pattern on a drum surface. Toner is then attracted to the area exposed by the laser and transferred to the paper. The paper is then passed over a heating element which melts the toner to form a permanent character.

Ink Jet Printers

Many types of ink jet printers are available. The simplest of these contains a series of ink jet nozzles in the form of a matrix. Vibrating crystals force ink droplets, roughly the diameter of a human hair, from selected nozzles to form an image in the same manner as an image is formed by a matrix printer. Different coloured inks may be used and combined to form additional colors.

Several hundred nozzles are employed in the more sophisticated ink jet printers to direct a continuous stream of droplets across the page to form an image. These charged ink droplets travel at speeds of up to 40 miles per hour as they move between a set of plates that deflect the droplets. Droplets not needed are electrostatically attracted away from the paper for reuse. A stream of more than 100,000 droplets can form approximately 200 characters per second.

2.6 Plotters

Plotters

An inexpensive portable plotter capable of generating multicolor plots from data is stored on magnetic tape or disk. Plotters with multicolor capabilities generally use a writing mechanism containing several pens, each capable of producing a different color. Some devices for automated drafting are equipped with plotting surfaces larger than 10 square feet and cost as much as a minicomputer system.

Whether an application is a general one (such as designing, mapping, or plotting schematics) or more specialized (such as three-dimensional data presentation, structural analysis, contouring, or business charts), there are plotters to do the tricks.

2.7 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 microfilm. At speeds of 10,000 to over 30,000 lines per minute, COM is one of the fastest computer output techniques-more than ten times faster than the fastest impact printer. A single roll of

microfilm can store approximately 2000 frames and costs less than half the cost to print the same amount of data on paper.

Computer output microfilm (COM) devices

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

2.8 Exercise

1. Multiple choice questions

a. Multi-colour images are produced in combination of

(i) Red, green and blue
(ii) Yellow, red and blue
(iii) Black , blue and white
(iv) none of the above combinations.

b. Dot matrix printer is

(i) an impact printer
(ii) a non-impact printers
(iii) laser printer
(iv) none of these categories.

c. In general which one of the following is the best quality printer?

(i) Dot matrix
(ii) Ink-jet
(iii) Desk-jet
(iv) Laser.

2. Questions for short answers

a. What is pixel of a monitor?
b. What are the following acronym stands for : COM and LCD?
c. Describe flat-panel display.
d. What is the difference between ink-jet and laser printers?
e. What is the difference between printer and plotter?

3. Analytical questions

a. Describe monitor display of computer systems.
b. Describe details of different impact and non-impact printers.
c. Draw the diagram of an ink-jet printer process and explain it briefly.

Lesson 3: Other Peripheral Devices

3.1 Learning Objectives

On completion of this lesson you will be able to :

- know some special peripheral devices
- understand characteristics and mechanism of such devices.

3.2 Terminals

Terminals are used for two-way communications with the CPU or with other terminals a few feet or thousands of miles away.

The terminal is a popular input/output device. Terminals are used for two-way communications with the CPU or with other terminals a few feet or thousands of miles away. With the aid of a terminal, a user can access computers around the world.

Terminals, also called workstations, allow to interact with a computer. It is required to use a keyboard to enter data and receive output displayed on a cathode ray tube (CRT) display screen, or monitor. Because data must be keyed into these devices one character at a time, the possibility of error is high and the data transmission rate very low, thus, limiting the use of these terminals to small-volume input and inquiries.

Terminal Functions

Some of the functions that can be performed using terminals are the following:

Message switching : The communication of information from one terminal to one or more remote terminals.

Terminal Functions

Data collection: Data are input to one or more terminals and recorded on a secondary storage medium for subsequent processing. This eliminates the needs to record the information on a source document and then to key the information from the source document into the 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 input from remote terminals directly to the 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 home video games displayed on a television set to sophisticated computerized systems, provide complex designs and three-dimensional displays in either black and white or color.

Terminals are available with features to suit the multitude of applications to which they are applied. In general three broad types of terminals are: point of sale, interactive remote, and intelligent.

3.3 Speech Recognition and Voice Response Devices

Speech recognition devices contain a database of stored voice patterns.

Speech recognition devices were introduced in the early 1970s. Typically, these systems contain a database of stored voice patterns. This database of voice patterns is generally stored in a recognition unit or in secondary storage. A microphone, attached to the keyboard or recognition unit, records the spoken word patterns. A built-in microprocessor then compares, word by word, these patterns with the stored patterns and transmits the results of the comparisons to a computer for processing. A sentence must be spoken as a series of disjoined words and numbers spoken as a series of digits and not as a single number. Speech recognition devices are generally used in situations where access to a switch or control is not possible or where a user's hands are otherwise occupied.

Because voice patterns vary greatly from person to person, most speech recognition services are speaker-dependent and must be fine-tuned to each operation. This is generally accomplished by having the operator speak each of the words or digits to be stored in the recognition unit dictionary several times. An average of the spoken voice patterns is taken and stored as the standard or mask against future voice communications will be compared.

Speaker-independent systems are less common and have a very restricted vocabulary-generally the ten digits and a "yes' or "no" response. Despite their restricted vocabulary, speaker-independent systems are widely usable since they do not have to be fine-tuned but can be understood by anyone. Clearly, speaker-independent systems are more desirable than speaker-dependent systems. but their great expense, large database requirements and the limitations of current technology have made their development tiresomely slow.

Speech recognition devices are currently employed in the preparation of numeric control tapes and in airline baggage sorting. Manufactures are beginning to offer very sophisticated speech recognition devices for the

more popular microcomputers. For example, more than a dozen such devices are available for the IBM microcomputers alone.

Voice response devices are commonplace in today's automated world. Warning sounds like "Warning! Warning! Your oil pressure is low" are being "spoken" by the voice response device in cars. The audio response is generally composed from a prerecorded vocabulary maintained in an external disk file. As an inquiry is received by the device it is sent to the computer for decoding. The computer then decodes and evaluates the inquiry and, from the prerecorded vocabulary on disk, constructs an appropriate digitally coded voice message, which is sent back to the audio response unit. The audio response unit then converts this message to a vocal reply, which is "spoken" to the inquirer. Such systems are not limited to one language. Vortrax, for example, manufactures an audio response unit that is capable of speaking in English French, German and Spanish.

Computer generated voice output devices cannot reproduce the subtle shading of intonation commonly used in everyday speech. Their main advantage lies in the fact that they can be understood more than 99 percent of the time and that people respond more quickly to the spoken word than to the written word. Areas of application are generally characterized by situations that require responses to inquiries or verification of data entered directly into a computer system. Audio-response devices are used in banks for reporting bank account balance information, in large businesses for credit checking and inventory status reporting. and in experimental research to alert a worker who might otherwise be distracted or involved.

Computer generated voice.

One of the strongest impacts made on the use of voice response has come from the manufacturers of microcomputers. The pricing and availability of voice response units are economically feasible for even the smallest concern. Voice response is no longer an isolated, esoteric discipline but another among the multitude of computer output techniques.

3.4 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.

A vision system utilizes a camera, digitizer, computer, and a technique known as image processing.

Familiar examples of computer-processed images are: computer generated digitized portraits for a few dollars at most amusement parks, computer-produced special effects in movies such as Star Wars,

digitized images of Jupiter and Saturn beamed from image processors onboard spacecraft to earth etc.

All of these examples have one thing in common that is to digitize an image. In a visual system, all images that must be recognized or interpreted must first be 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 interpreting images, begins when the system digitizes the image of the object to be interpreted. This 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.

3.5 Exercise

1. Multiple choice questions

(a) The terminal is

(i) input device
(ii) output device
(iii) input / output device
(iv) none of the above.

(b) Which one is the function of terminal?

(i) vision system
(ii) message switching
(iii) CRT
(iv) CPU.

2. Questions for short answers

(a) What is a terminal ?
(b) Briefly describe the functions of a terminal.
(c) What is the purpose of the vision system ?
(d) What do you understand of speech recognition ?

3. Analytical question

(a) Explain in details about the I/O devices that can be used as both input and output devices.