

S. Y .B. Sc.  
Computer Science  
US03CCS02: Computer Organization  
Unit – 4

## OUTPUT DEVICES

An **output device** is any piece of computer hardware equipment used to communicate the results of data processing carried out by a computer system to the outside world.

In computing, input/output, or I/O, refers to the communication between an information processing system (such as a computer), and the outside world. Inputs are the signals or data sent to the system, and outputs are the signals or data sent by the system to the outside.

Computer output devices deliver data that has been processed by the computer to the user. There are a variety of devices that produce data in different forms including audio, visual and hard copy. Computer output devices are types of peripheral hardware connected to a computer, using cables or over a wireless network.

Examples of output devices:

- Monitors, Printer, Plotter, Speaker, scanner

## VDU

- A monitor is a box containing a CRT (Cathode Ray Tube) and its power supplies. The CRT contains a gun that can shoot an electron beam against a phosphorescent screen near the front of the tube, as shown in Fig. 2-31 (a). (Color monitors have three electron guns, one each for red, green, and blue.) During the horizontal scan, the beam sweeps across the screen in about 50 usec, tracing out an almost horizontal line on the screen. Then it executes a horizontal retrace to get back to the left-hand edge in order to begin the next sweep. A device like this that produces an image line by line is called a raster scan device.
- Horizontal sweeping is controlled by a linearly increasing voltage applied to the horizontal deflection plates placed to the left and right of the electron gun. Vertical motion is controlled by a much more slowly linearly increasing voltage applied to the vertical deflection plates placed above and below the gun. After somewhere between 400 and 1000 sweeps, the voltages on the vertical and horizontal deflection plates are rapidly reversed together to put the beam back in the upper left-hand corner. A full-screen image is normally repainted between 30 and 60 times a second. Although we have described CRTs as using electric fields for sweeping the beam across the screen, many models use magnetic fields instead of electric ones, especially in high-end monitors. To produce a pattern of dots on the screen, a grid is present inside the CRT. When a positive voltage is applied to the grid, the electrons are accelerated, causing the beam to hit the screen and make it glow briefly. When a negative voltage is used, the electrons are repelled, so they do not pass through the grid and the screen does not glow. Thus the voltage applied to the grid causes the corresponding bit pattern to appear on the screen. This mechanism allows a binary electrical signal to be converted into a visual display consisting of bright and dark spots.

## LCD Monitors

LCD (Liquid Crystal Display) displays were used on laptop computers before the technology improved enough to make the jump to desktop monitors. An LCD monitor consists of five layers: a backlight, a sheet of polarized glass, a "mask" of colored pixels, a layer of liquid crystal solution responsive to a wired grid of x, y coordinates, and a second polarized sheet of glass. By manipulating the orientations of crystals through precise electrical charges of varying

degrees and voltages, the crystals act like tiny shutters, opening or closing in response to the stimulus, thereby allowing degrees of light that have passed through specific colored pixels to illuminate the screen, creating a picture.

Flat panel monitors usually use LCD or plasma to create output. Light is passed through liquid crystals to create the pixels.

### Advantages of LCDs

- Light weight; can be about 15 lbs for a thin LCD.
- Smaller footprint on desk leaving, freeing up work area on the user's desk.
- Flicker free screen.
- More usable display area than on comparably sized CRTs.
- Low frequency radiation is practically eliminated.
- Easy adjustment, storage, and movement
- Energy efficient, using only 1/3 to 1/2 the electricity of CRTs, and they don't generate heat.
- Potentially less eyestrain due to reduced screen glare.
- Good for basic web surfing.
- Newest TFT liquid crystal technology has provided LCDs in competitive position with CRTs for image and color clarity.
- OLED, a new technology (Organic light-emitting diodes) in limited use presently in handheld personal video players, uses little power and provides a better image than present LCD technology; it thus holds the promise of making up for a significant weakness in LCD image quality.
- Plentiful mounting arm options available, enabling these light LCDs, whether computer or TV monitor to be ergonomically raised off the work surface.

### Disadvantages of LCD's

- Fragile screen; may result in both screen and backlight lamp damage if touched or handled. Thus, not recommended in environments where it may be handled roughly.
- Contrast ratio causes darkness to not be displayed true. Darkest areas may be viewed as dark gray rather than black.
- Designed only for one optimum resolution; can't adjust images.
- Best view of screen is straight-on, limiting clarity and colors of information for those viewing from an angle.
- The backlight is the potential weak link and its failure can be costly. Many warranties only cover it for 1 year.

### TFT Monitors

- A TFT monitor uses **Thin-Film Transistor** technology for the ultimate LCD display. LCD monitors, also called flat panel displays, are replacing the old style cathode ray tubes (CRTs) as the displays of choice. Nearly all LCD monitors today use TFT technology.
- The benefit of a TFT monitor is a separate, tiny transistor for each pixel on the display. Because each transistor is so small, the amount of charge needed to control it is also small. This allows for very fast re-drawing of the display, as the image is re-painted or refreshed several times per second
- Prior to TFT, *passive matrix* LCD displays could not keep up with fast moving images. A mouse dragged across the screen, for example, from point A to point B, would disappear between the

two points. A TFT monitor can track the mouse, resulting in a display that can be used for video, gaming and all forms of multimedia.

## **Printers**

Printers are the most commonly used output devices used to prepare permanent documents on paper.

Printers are basically classified in two types

1. Impact Printer
2. Non-Impact Printer

**Impact Printer** uses some kind of impact (force) to achieve the effect of print on the paper. Some form of mechanism like print hammer or head is made to strike against the paper to create the impression on the paper.

### **Characteristics:-**

- Use some force for printing
- Less costly
- These type of printers produce a noise and the printing quality is not that much good
- E.g. Dot matrix printer, Drum (line) printer

**Non-Impact Printer** uses some special chemical to make impression on the paper.

### **Characteristics:-**

- Very costly
- Very high quality of output
- Produce no noise
- E.g. Laser printer, Inkjet printer

## **Dot Matrix Printer**

- Dot matrix printer print only one character at a time. It prints any character or image as pattern of dots.
- Dot matrix printer has a print head, which can move horizontally (left to right and right to left) across the paper. The print head contains the array of pins. To print a character, the printer activates the appropriate set of pins as the print head moves horizontally.
- Dot matrix printer can print any shape of character as well as many special characters, graphics, charts etc. the speed of dot matrix printer is 30 to 600 characters per second. This printer is able to print multiple copies of a document in a single printing.
- The term dot matrix printer is specifically used for impact printers that use a matrix of small pins to create precise dots. The advantage of dot-matrix printers is that they can produce graphical images in addition to text; however the text is generally of poorer quality.
- Dot matrix printers were one of the more common types of printers used for general use, such as for home and small office use. Such printers would have either 9 or 24 pins on the print head. 24-pin print heads were able to print at a higher quality.

### **Advantage:-**

- It is cheaper
- It is able to print multiple copies of a document in a single printing
- It is able to print any character, many special characters and graphics

### **Disadvantages:-**

- It is noisy
- Printing quality is not that much good

- It is slow
- Not suitable for bulk printing

### **Line (Drum) Printer**

- Line printer is an impact printer that prints one line at a time. It consists of solid, cylindrical drum with characters raised (embossed) on its surface.
- Each band consists of all the possible characters. The printer has a set of hammers mounted on the drum. The drum rotates at a high speed and a character is printed by activating the appropriate hammer, when the character embossed on the band passes below it.
- One revolution of the drum is required to print one line. This means that all characters on the line are not printed at exactly at the same time, but the time required to print the entire line is so fast that it appears as one line is printed at a time
- Typical speeds of line printers are in range of 300 to 2000 lines per minute.
- Its disadvantage is that it is noisy and do not have ability to print any shape of characters, different size of print and graphics.

### **Laser Printer**

- Laser printer is a non-impact printer. It is a page printer which prints one page at a time.
- The main components of laser printer are a laser beam, a multi sided mirror, a photoconductive drum and toner. To print a page, the laser beam is focused on the drum by the spinning multisided mirror. The mirror focuses the laser beam on the surface of the drum in a manner to create pattern of characters/images to be printed on the page.
- Speed of laser printer is 500 to 1000 pages per minute.
- Its advantages are that the quality of output is very high and is the fastest printer.
- Its disadvantage is that it is very expensive and its maintenance cost is high also it cannot produce multiple copies of a document in a single printing.

### **Ink Jet Printer**

- Ink-jet printer is a non-impact printer. It prints characters by spraying small drops of ink onto the paper. The printer consists of array of nozzles, from which the ink comes out. Ink is stored in the printer in a tank called ink cartridge. There are four cartridges – one for each cyan, magenta, yellow, black. This means that it's possible to have the colored printing.
- An inkjet printer is a type of computer printer that reproduces digital image by propelling variably-sized droplets of liquid material (ink) onto a page. Inkjet printers are the most common type of printer and range from small inexpensive consumer models to very large and expensive professional machines. A high-pressure pump directs liquid ink from a reservoir through a gun body and a microscopic nozzle, creating a continuous stream of ink droplets.
- The ink droplets are subjected to an electrostatic field created by a charging electrode as they form; the field varies according to the degree of drop deflection desired.
- Its produce very high quality output because it forms characters by very high tiny ink dots
- The speed of ink-jet printer is 40 to 300 characters per seconds. It is slower than dot matrix printer but it is more expensive than dot matrix printer.
- The document printed may contain multiple characters styles and a verity of type sizes.
- It cannot produce multiple copies of a document in a single printing.

## **Advantages**

- Inkjets have the advantage of practically no warm up time and lower cost per page.
- They can print finer, smoother details through higher print head resolution.
- Lowest purchasing cost.

## **Disadvantages**

- The lifetime of inkjet prints produced by inkjets using aqueous inks is limited; they will eventually fade and the color balance may change.
- Because the ink used in most consumer inkjets is water-soluble, care must be taken with inkjet-printed documents to avoid even the smallest drop of water, which can cause severe "blurring" or "running." Similarly, water-based highlighter markers can blur inkjet-printed documents.
- The very narrow inkjet nozzles are prone to clogging with dried ink. The ink consumed cleaning them - either during cleaning invoked by the user, or in many cases.

## **Input Device**

They are computer devices that inputs information in the computer. Input basically means getting data into the computer to be processed.

### **Ex:**

Keyboard, Numeric Keypads, Mouse, Touchpad, remote control, joysticks, touch screen, magnetic strip readers, chip readers, scanners, digital cameras, microphones, sensors, barcode reader, webcam, video cameras etc.

## **Key Board**

- Keyboard of the computer is quite looking like similar to that of typewriter but it contains some addition keys then the normal typewriter.
- It is electromechanical devices & it connects through cable. One end of cabal is connected to the special input port of computer & another end is connected to the keyboard
- When a key pressed on a keyboard there is a matrix on which contact is done, at that time it generate the electronic signal which is detected by the electronic circuit called keyboard encoder. So keyboard encoder is detecting the key which key pressed.
- Keyboards have keys that just make mechanical contact when depressed. Better ones have a sheet of elastomeric material (a kind of rubber) between the keys and the underlying printed circuit board. Under each key is a small dome that buckles when depressed far enough. A small spot of conductive material inside the dome closes the circuit. Some keyboards have a magnet under each key that passes through a coil when struck, thus inducing a current that can be detected. Various other methods, both mechanical and electromagnetic, are also in use.
- On personal computers, when a key is depressed, an interrupt is generated and the keyboard interrupt handler (a piece of software that is part of the operating system) is started. The interrupt handler reads a hardware register inside the keyboard controller to get the number of the key (1 through 102) that was just depressed. When a key is released, a second interrupt is caused. Thus if a user depresses the SHIFT key, then depresses and releases the M key, then releases the SHIFT key, the operating system can see that the user wants an uppercase "M" rather than a lowercase "m." Handling of multi key sequences involving SHIFT, CTRL, and AL T is done entirely in software (including the infamous CTRLALT-DEL key sequence that is used to reboot all IBM PCs and clones).

## Mouse

- A mouse is small hand-held box used to position the screen cursor. Wheels or rollers on the bottom of the mouse can be used to record the amount and direction of movement. A mouse can be picked up and put down at another point without change in cursor position. Two or three buttons are usually included on the top of the mouse for signaling the execution of some operation.
- A similar device called the Z Mouse includes three buttons, a thumbwheel on the side, a trackball on the top and the standard mouse ball under it. We can pick up an object, rotate it, and move it in any direction, and other three- dimensional application is possible using the Z mouse.

## Scanners

In computing, a 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, gaming and other applications. Mechanically driven scanners that move the document are typically used for large-format documents, where a flatbed design would be impractical.

### • Addressing :--

Instructions can be classified according to the number of addresses they use. It should be kept in mind that a collection of numbered CPU registers, in effect, forms a high-speed memory and defines an address space. An instruction that adds register 1 to register 2 should be classified as having two addresses because the instruction must specify which registers are to be added, just as an instruction that adds two memory words must specify which words.

Two-address add instructions use one address as the source and the other as the destination. The source is then added to the destination:

destination := destination + source

### Immediate Addressing:

The simplest way for an instruction to specify an operand is for the address part of the instruction actually to contain the operand itself rather than an address or other information describing where the operand is. Such an operand is called an **immediate operand** because it is automatically fetched from memory at the same time the instruction itself is fetched; hence it is immediately available for use. A possible immediate instruction for loading register R1 with the constant 4 is shown in [Fig. 5-17](#).

MOV	R1	4
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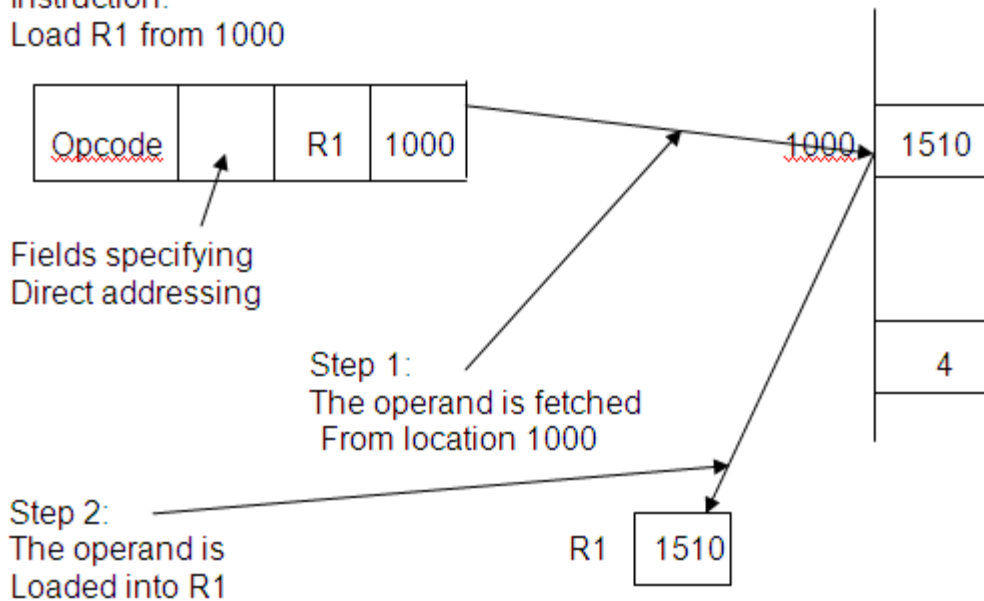
An Immediate Instruction for loading 4 into register 1.

### Direct Addressing:

A method for specifying an operand in memory is just to give its full address. This mode is called **direct addressing**. Like immediate addressing, direct addressing is restricted in its use: the instruction will always access exactly the same memory location. So while the value can change, the location cannot. Thus direct addressing can only be used to access global variables whose address is known at compile time. Nevertheless, many programs have global variables, so this mode is widely used. The details of how the computer knows which addresses are immediate and which are direct will be discussed later.

Instruction:

Load R1 from 1000



### Register Addressing:

Register addressing is conceptually the same as direct addressing but specifies a register instead of a memory location. Because registers are so important (due to fast access and short addresses) this addressing mode is the most common one on most computers. Many compilers go to great lengths to determine which variables will be accessed most often (for example, a loop index) and put these variables in registers.

This addressing mode is known simply as **register mode**. In load/store architectures such as the UltraSPARC III, nearly all instructions use this addressing mode exclusively. The only time this addressing mode is not used is when an operand is moved from memory into a register (LOAD instruction) or from a register to memory (STORE instruction).

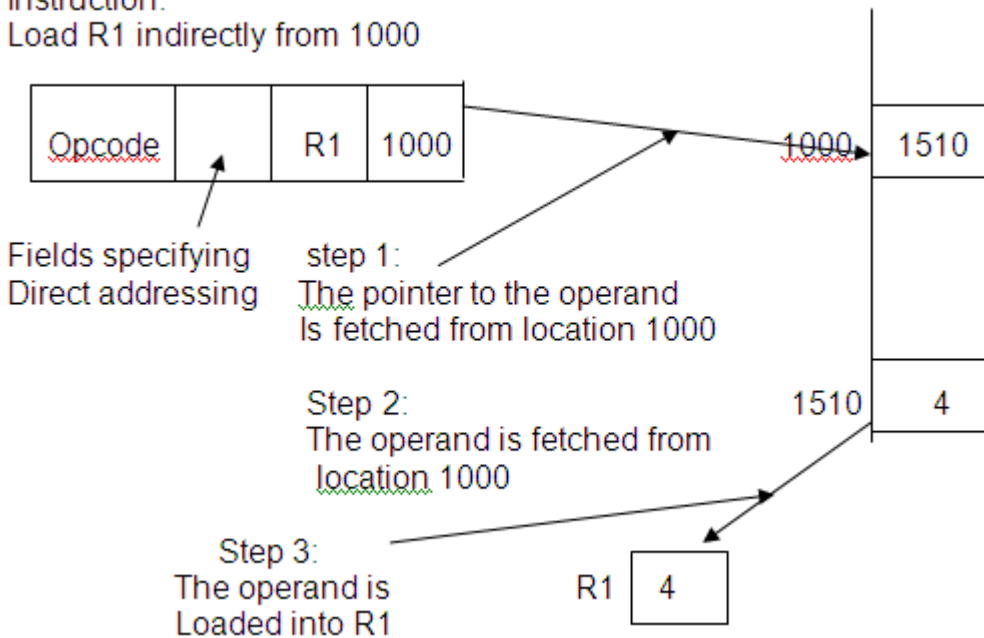
### Indirect Addressing:

Direct addressing is a scheme in which the address specifies which memory word or register contains the operand. Indirect addressing is a scheme in which the address specifies which memory word or register contains not the operand but the address of the operand. As shown in the fig. , consider an instruction to load a register (which we will call R1) indirectly from memory location 1000, where location 1000 contains 1510.

First, the contents of location 1000 are fetched into an internal CPU register. This 16-bit number (1510) is not put in R1. If it were, as in fig., we would have a direct address instruction. Instead, the contents of location 1510 are fetched and put into R1. The number at location 1000 is not the operand but instead it “points to” the operand. For this reason, it is called a pointer.

Instruction:

Load R1 indirectly from 1000



### Indexing:

Many algorithms require performing some operation on a sequence of data structures stored in consecutive memory locations. For example, consider a block of  $n$  machine words occupying locations

$$A, A+1, A+2, \dots, A+n-1$$

which must be moved to locations

$$B, B+1, B+2, \dots, B+n-1$$

Assuming that the machine has an instruction **MOVE A, B**

that moves the contents of location  $A$  to location  $B$ , one could execute this instruction, modify the instruction itself to read **MOVE A+1, B+1**

Execute it again, then modify it again and repeat the cycle until all  $n$  words had been copied.

Although programs that modify themselves were once popular, they are now considered bad programming practice. They are difficult to debug and they make sharing of a program among several users of a time-sharing system difficult.

The copying problem can also be solved by indirect addressing. One register or memory word is loaded with the address  $A$ ; a second one is loaded with  $B$ . The MOVE instruction uses these two as pointer. After each word has been copied, the pointers are each increased by one. The pointers are part of the data, not part of the program, of course, and are not shared by simultaneous users.

Another solution is to have one or more registers, called index registers, which work as follows. Addresses have two parts, the number of an index register and a constant. The address of the operand is the sum of the constant and the contents of the index register. In the above example, if both addresses are indexed using an index register containing the integer  $k$ , the instruction **MOVE A, B** will move the contents of memory location  $A+k$  to  $B+k$ . By initializing the index register to 0 and incrementing it by the word size after each word is copied, only one register is needed for the copy loop. Furthermore, incrementing a register is faster than incrementing a memory location.

In the above example given above it was necessary to explicitly increment the index register by the word size after each use of it. The need to increment or decrement an index register just before or after it is used is so common that some computers provide special instructions or addressing modes, or even special index registers that automatically increment or decrement themselves. Automatic modification of an index register is called autoindexing.



## Stack Addressing:

Making machine instructions as short as possible is highly desirable for saving both CPU time and memory. The ultimate limit in reducing address lengths would be to have instructions with no addresses at all, just op codes. Surprisingly enough, this situation is possible. It is accomplished by organizing the machine around a data structure called a stack.

A stack consists of data items (words, characters, bits, etc.) stored in consecutive order in the memory. The first item pushed onto the stack is said to be at the bottom of the stack. The item most recently pushed onto the stack is said to be on the top of the stack. Associated with each stack is a register or memory word that contains the address of the top of the stack. It is called the stack pointer.

Computers that are stack-oriented have an instruction to push the contents of a memory location or a register onto the stack. Such an instruction must both copy the item and increment the stack pointer. Similarly, an instruction to pop the top of the stack into a register or memory location must make a new copy in the proper place and decrement the stack pointer. Some computers have their stacks upside down, with new items being pushed into consecutively lower numbered memory locations rather than consecutively higher numbered locations.

Instructions with no addresses are used in conjunction with a stack. This form of addressing specifies that the two operands are to be popped off the stack, one after another, the operations performed (e.g. multiplication or AND) and the result pushed back onto the stack.

### Stack Pointer:

