COMPUTER ORGANIZATION AND ARCHITECTURE

Lecture 7

Input, Output and Storage Components

Dr Victoria Mukami

INTRODUCTION

This lecture is a combination of several categories of hardware. We will review input, output and storage devices throughout the unit. We will also do a discussion on the characteristics of each device. Finally, we will review the different types of devices for each hardware category

Learning objectives

By the end of this topic, you should be able to:

1. Describe various input devices and their characteristics
2. Describe various output devices and their characteristics
3. Understand and list the various storage devices and their role on the computer system

OVERVIEW

During our first lecture, we reviewed the basic functions of a computer. We saw this as input, processing, output, and storage. We have so far been able to review processing devices during lecture 3, where we reviewed the central processing unit. We defined input as an acceptance of data or information by a computer. Output was defined as the display of results or information while storage was defined as keeping data for future reference. During this lecture, we now review the devices that aid in the three functions: input, output, and storage.

1. Input devices

These are those devices that allow a user to enter data, instructions, or commands into the computer. Input devices vary and will allow for a variety of data such as text, numbers, audio, images and even videos to be inserted into the computer. A microphone is the main audio input device. It is used to capture sound, voices or music and transfer them to the computer. A digital camera is an example of a device used to input videos or pictures into a computer. The devices also vary on the type of data that is being inserted and we review the devices in the section below.

1.1. Keyboard

A keyboard is an input device that consists of letters and symbols and characters. A keyboard allows you to type in text, give commands or instructions. A typical keyboard will contain letters, numbers, and various characters. In addition, a keyboard will also

contain a numeric keypad, function keys, Delete and Backspace keys, Ctrl and Alt keys and arrow keys [4]. The function keys range from F1 to F12 and are used to issue commands. These commands vary from one program to another. Keyboard types vary from flexible keyboards to ergonomic keyboards and wireless keyboards to virtual keyboards. The use or preference of the type of keyboard is dependent on the user's task or main use of the keyboard.

1.2. Mouse

A mouse is considered a pointing device. Pointing devices are used to select and manipulate objects, input certain types of data, and issue commands to the computer [4]. A mouse is normally used on a flat surface and is used by moving it on the flat surface and pressing the various buttons on it. A typical mouse will have three main buttons. One button on the left, on the right and a scroll button. When one moves the mouse, the cursor on the screen moves and when the user clicks with one of the buttons a command is issued. There are various types of mice including mechanical mice (which uses a ball on the underside of the mouse to aid in moving it), laser mouse (which uses a laser light underneath to guide movement of the mouse), and wireless mouse (this mouse do not have a wire connecting them to the computer). It is worth mentioning that there are two types of pointing devices known as the touchpad and trackball. The touchpad is the equivalent of a mouse found on a laptop. A trackball on the other hand is like a mouse but has a ball at the top that users can roll around to make the cursor on the screen move. It is considered as the ergonomic option of the mouse.

1.3. Scanner

A scanner is a device that is used to capture an image of an object in digital form and then transfers that data to a computer [4]. A scanner can be used to transfer written materials such as a book, a photograph or even receipts. Normally, text or images that are scanned are not editable. A scanner is useful for converting old hard copy documents to their soft copy version. This includes books in libraries and documents in corporations. Scanners have come a long way where one could use an optical character recognition (discussed under readers) scanning tool to make scanned documents editable. This is especially helpful when one needs to search through long documents. There exist two types of scanners, a flatbed scanner that lays flat and is

mainly used to scan documents and a portable scanner that can scan on the move and is handheld.

1.4. Readers

A reader is a tool that reads various characters, letters, numbers and marks and translates them to the digital form or is used to pull up the information corresponding to what was read. Several readers exist:

Barcode reader - This is used to read barcode data from various products. The most commonly place a barcode reader is found is in the supermarket. It reads the barcode and translates the information into product details and aids in the compilation of a receipt.

Optical Mark Reader - This is used to read marks from sheets that have been made with a pencil. The best example is the exams that are done on Scranton papers. The OMR can read each student's answer, mark it and assign marks.

Biometric Readers - These are readers used to read biometric data such as fingerprints and scan eyes. Biometric readers are found on most smartphones and are used to unlock the phones using fingerprints.

2. Output Devices

These are those devices that allow a user to view the results after input of various instructions, commands, or data. There are two main output devices: the monitor and the printer. However other output devices that allow for audio to be heard exist such as speakers or headphones are used as sound output and will allow a user to hear sounds from the computer. A projector is another output device that allows for information to be displayed. A projector differs from a monitor as it can project (make bigger) to a wall.

2.1. Monitor/Display Device

A display device is used to show the results of a computer. By results, I do not mean data that has been processed, this also accounts for data that the user is typing. A display device can be a monitor or even a television screen. On a laptop machine, the display device is attached to the entire unit. We will first review three characteristics of a display device before looking at the various types.

2.1.1. Colour vs Monochrome

A monitor is either considered to display many different colours or is considered to display only one of two colours in many different shades known as monochrome. A monochrome monitor may display black and white in varying shades [4]. Previously monitors could only display colour in black and white. Nowadays though, display units come by default with colour.

2.1.2. CRT vs Flat Panel

CRT stands for Cathode Ray Tube and was an older technology of display unit that used the CRT technology to display images [4]. The CRT monitors were huge and had a hunchback making them bulky monitors. Additionally, the monitors were not clear due to the size and the number of pixels within the display surface. We discuss pixels in the next section. On the other hand, flat-panel technologies are a smaller more compact monitor that uses various technologies to display. The various flat technologies will be discussed under the types.

2.1.3. Screen Resolution

Before we talk about the screen resolution, it may be important to discuss the size of a monitor. Monitor sizes will vary and are normally attributed to inches. Most laptops are found within the 11 to 15-inch screen. Desktop monitors could go up to 24-inch monitors. The monitors are normally measured diagonally [4]. This range is dependent on the user preference and use of the machine. For instance, a gamer and a creative might prefer a bigger monitor or even multiple monitors to carry out their function.

The resolution focuses on the display area which is divided into pixels [4]. A pixel is the smallest colourable area found within a display unit [4]. Resolution is therefore determined by the number of pixels, where this factor by the total number of pixels within a screen. This means the higher the resolution, the clearer the display and the more information that can be displayed within the screen. An example of a resolution is 1024 by 768.

Next, we look at the three main types of monitors.

2.1.4. Plasma Monitors

A plasma monitor is an older type of display unit that uses two layers of glass to reflect light and display its contents [4]. Plasma units were used especially with very large display units but this has been replaced with LEDs in recent times. [4].

2.1.5. LCD Monitors

LCD stands for liquid crystal display which is a type of technology that uses charged liquid crystals to light up the screen [4]. These liquid crystals are normally found between two sheets of clear plastic or glass. LCD screens must use what is known as reflective light to display contents on the screen. A back panel is a common feature on LCD's as it provides the reflective light within the panel that is needed to show the images.

2.1.6. LED Monitor

LED stands for light-emitting diode and is a technology that used LED backlights within an LCD panel [4]. The LED lights are used in many other products such as Christmas lights and alarm clocks [4]. A newer technology called Organic LED (OLED) is being used where organic material in layers can emit light when a current is passed through it. LED's and more so OLEDs are more compact (thinner) than their LCD counterparts.

2.2. Printers

The second type of output device is the printer. A printer is a device that is used to provide a hard copy from the digital form. Generally, a printer will print its output on paper. Several printer characteristics are discussed below.

2.2.1. Impact vs Non-Impact Printers

This is the type of technology that the printer prints with. Impact printers are those that strike the paper when printing. The printer cartridge has direct contact with the paper. The printer is normally useful especially in the business setting where one is expected to print in copies of the same document i.e., a receipt where a customer would get a copy while the business was left with their copy. A non-impact printer is one where the cartridge does not strike the paper or does not touch the paper being printed on. Non-impact printers produce higher resolution images compared to impact printers. Non-

impact printers are more commonly used as they are less noisy and more compact than their impact counterparts.

2.2.2. Resolution and Speed

As discussed in the previous section, the resolution is related to the number of pixels that can be displayed within a specific section. In printing, the resolution is considered as the number of dots per inch (dpi) during printing [4]. The higher the number of dots per inch the higher the image quality printed. General-purpose printing will use approximately 300 dpi while professional high-quality printing could go up to 2400 dpi.

Printing speed refers to how fast a printer can produce printouts. This is measured by a unit known as pages per minute (ppm). This is of course dependent on what is being printed.

2.2.3. Colour vs Black and White

Printers can either print in colour or black. Black printers use black ink to print on white or any other coloured paper. Coloured printers use colours (red, blue, and yellow toners) to print various colours on paper. A mix of these colours results in additional colours.

Next, we discuss the types of printers.

2.2.4. Laser Printers

These are the most used printers by both individuals and businesses. These printers vary in size and are either coloured or black and white. A laser printer is a type of non-impact printer that uses a laser beam to guide the ink to the paper. Ink is stored in a toner before release during printing. These printers produce high-quality print work and are faster than other printers.

2.2.5. Inkjet Printers

These are other forms of non-impact printers that spray the ink onto paper during printing. Generally, the ink cartridge will travel the width of the paper as printing occurs. Inkjet printers are relatively cheap and provide good quality images and are therefore the choice of printer for personal use.

2.2.6. Dot-matrix Printers

These are the kind of printers you will mainly find in banking halls, hospitals, and other businesses (water and electricity companies) that produce lots of triplicate receipts. Dot-matrix printers are bulky and much noisier than their counterparts. They are a form of an impact printer that strikes the paper when printing. This is helpful, especially when producing duplicate or triplicate printouts. They use a specific type of paper to be able to produce several copies within one printout.

3. Storage Devices

These are those devices that allow a user to store the results after input, processing and output of various instructions, commands, or data. Storage devices have specific characteristics, and these are discussed below.

3.1. Media and Devices

A storage media is hardware where the actual data is stored [4] while a storage device is a device where the storage medium is inserted. The storage device can either be internal or external. On the other hand, the storage medium is considered as either removable or permanent. In some cases, the storage medium and storage device are fused and act as one. A good example of a storage medium is a DVD with its corresponding storage device is the DVD drive. An example of a fused storage medium and device is the USB flash disk.

3.2. Random vs Sequential Access

When data must be retrieved from a storage medium the data is accessed in a specific way. In Random access, the data is retrieved in any order. The data don't need to be retrieved in the order in which it was written to the medium. USB and DVDs are good examples of devices that use random access types of retrieval.

Sequential access refers to data that can only be retrieved based on the way it was physically written to the medium [4]. A good example of a medium that uses sequential storage is magnetic tape drives that are used to perform backups.

3.3. Logical vs Physical Representation [4]

Logical file representation is the logical way in which a computer shows where data is stored. For instance, a user could decide to store files in drive D under a folder called

Student files and under a subdirectory called semester 2. This is not the physical location of the file but a logical representation that makes it easier for the user to retrieve the files.

Physical representation represents where a file is physically stored on the storage medium. Computers could physically store a file in various sections of the medium. Users need not be concerned about where the file is stored physically as the data storage is represented logically.

Next, we discuss the various types of storage devices.

3.4. Hard Drive

A hard drive is the typical storage device that is found within a computer or laptop. Hard drives can either be internal or external. It is good to note though that, except for computers that use network storage, a hard drive is an expected storage device of any machine. Different types of hard drives exist.

A magnetic hard drive is the traditional type of hard drive used. These hard drives are normally sealed in a metal case and contain several rotating disks (cylinder) stacked one on top of the other. These hard drives also contain a rotating shaft and read and write heads that are used to read the hard drive contents. Each cylinder consists of tracks (concentric rings) and pie-shaped groups of sectors (small pieces of a track) with the smallest amount of disk space known as a cluster (1 or more sectors).

A Solid-State Drive (SSD) is a newer type of hard drive that uses flash memory. Remember during the third lecture when we discussed memory. One of the types of fast ROM (EEPROM) that we discussed was flash memory. SSDs use flash memory to provide faster access to data. SSDs are generally more expensive than magnetic drives.

3.5. Optical Disks

An optical disk is a thin circular disk that is used to store data [4]. An optical disk does not contain tracks like the magnetic drive but contains a single spiral track also divided into sectors. The disks are made of a strong type of plastic material and are topped with layers of coatings to aid in the storage of data and to protect the device. This also means that the device must be handled safely as it can break or be scratched,

rendering the data stored inaccessible. Examples of Optical Disks include DVD-ROM (Digital Versatile Disc) and CD-ROM (Compact Disc). The storage device used includes CD and DVD drive.

3.6. Flash Memory mediums

This is a small-medium that contains a small number of memory chips and is used to store data [4]. The number of flash memory chips will determine the storage capacity of the device. The medium contains additional electronic components and circuitry that allows access and storage of data. Examples of flash memory mediums/devices include SD (Secure Digital) cards and USB flash drives. The SD card is commonly used on phones to increase the storage capacity of a phone.

3.7. Network and Cloud Storage

Network and cloud storage refers to storage not found within the computer or device but can be accessed using a network or the internet. Network storage will allow for access through a local network and access is to a remote storage device [4]. The most common type of network storage used includes the Network Attached Storage (NAS) and the Storage Area Networks (SAN) [4]. Cloud storage on the other hand is accessible through the internet and refers to the top paid or free type of storage. The most common are Google Drive and One Drive.

SUMMARY

During this lecture, we have done a review of various hardware devices. First, we reviewed input devices and their role in a computer system. We then reviewed two main output devices, the display unit and printer, and their characteristics. Finally, we reviewed the storage device characteristics and discussed four main types of storage devices. Next lecture we review software and specifically the application and system software

DISCUSSION TOPIC

As computers change and become smaller, faster, and more efficient, one of the ways to ensure this is not in vain is to ensure that storage devices can match up to the inventions. Using web research, identify ways in which storage devices can keep up with the speeds currently seen within computers.

REFERENCES

[1] G. Shelly and M. Vermaat, Discovering Computers — Fundamentals: Your Interactive Guide to the Digital World. Boston, MA: Course Technology, 2012.

[2] W. Stallings, Computer Organization and Architecture Designing for Performance. Hoboken, NJ: Pearson Education, Inc, 2016.

[3] A. Evans, K. Martin and A. Poatsy, Technology in Action. New York, NY: Pearson, 2020

[4] D. Morley and C. Parker, Understanding Computers: Today and Tomorrow. Boston, MA: Course Technology, 2017.