3.6 Input and Output Devices

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Definitions

1. **input device**

   - a device that allows data to be entered into a computer system

2. **output device**

   - a device that can be used to obtain the results of data that has been processed

Input Devices

In this section, you need to remember the different input devices and how are they used in different scenarios. You don't need to pay much attention to the principles of how these devices work

1. **Barcode Scanner**

   - scan in the **barcode** (条形码)

   - used in **checkout stations** in supermarkets or shops

   - benefits of using barcodes include,

     1. **barcodes are efficient**

        - by simply scanning the barcode, all the information about the products can be accessed

     2. **barcodes are time-saving**

        - by scanning the barcode, the information about the products can be stored inside a database, so that the managers don't need to type in the information one by one

     3. **barcodes reduce erroes**

        - barcodes reduce clerical and data entry errors as you only need to scan it and every barcode is unique for a specialized product

2. **Digital Camera**

   - cameras that capture photographs in digital memory (数码相机)

   - we can use digital cameras too,

     1. **upload homework on teams**

     2. **record pretty moments of a trip**

     3. **etc**

3. **Keyboard**

- 键盘
- used to type in letters or symbols into the computer system

4. **Microphone**

- 麦克风
- record the acoustic data, used in sound systems for example

5. **Optical mouse**

- 光学鼠标
- used to access a specific position of the computer screen and to make selections through clicks
- however optical mouses may suffer from some erroneous movements

6. **QR code scanner**

- scan in the **QR codes** (二维码)
- QR codes are used in WeChat Pay (electronic payments) and also track information on products on a supply chain
- benefits of QR codes include,

    1. **QR codes promote sharing and networking for multi-media content**

        - you could generate a QR code for your document or your video, and anyone can access to this content by simply scanning the QR code
    2. **QR code content is accessible through mobile devices**

        - you don't need a specialized tool to scan the QR code, mobile phones and tablets can scan the codes for you

7. **Scanners**

    1. **2D scanners**

        - just like how printers in your home scan in the document and make a copy of it
        - it scans the content on a piece of paper and makes a digital 2D copy of the content
    2. **3D scanners**

        - it scans the 3D model of a real object so that you could make a physical copy of the item

8. **Touch Screen**

- touch screen is the assembly of both an input and output device
- it allows you to do operations on the system by touching it with your fingers
- there are three types of touch screens, **resistive**, **capacitive**, and **infra-red**

Resistive	Capacitive	Infra-red
functions when pressure is exerted	functions when an electrical conductor (your finger) moves near the screen	functions when an object disrupts the infra-red matrix

Touch screen technology	Advantages	Disadvantages
Capacitive	• better image clarity than other technologies • very durable screens with good scratch resistance • allows multi-touch facility	• surface capacitive screens only allow use of bare fingers or stylus • sensitive to electromagnetic radiation
Infrared	• allows multi-touch facility • good screen durability • not affected by scratched/cracked screen	• can be sensitive to water/moisture on screen surface • possible accidental activation • sensitive to light interference
Resistive	• good resistance to dust and water • can be used with fingers, stylus or gloved hand	• low touch sensitivity • doesn't support multi-touch facility • poor visibility in strong sunlight • vulnerable to scratches on screen

- **capacitive** screens are the **most responsive** type of touch screen that is widely used in **mobile phones**
- in some old phones which used the stylus to make a "touch", they used **resistive** screens
- **infra-red** screens are usually used in smart whiteboards(智能白板)

Output Devices

1. **Actuator**

   - it helps to perform **physical movements** of the components
     - it **moves** something
     - such as how those automatic doors slide

2. **Projectors**

   - **Digital light processing (DLP) Projector**

     - beams light through a color wheel, reflection mirrors, then finally a lens (just get the idea you don't need to remember that)
     - its benefits include,

       1. higher contrast ratios
       2. greater longevity
       3. quieter running
       4. portable (smaller and lighter than LCD projectors)
       5. better suited to dusty and smoky atmospheres
     - its drawbacks include,

       1. do not have grey components in the image
       2. relatively lower color definition
       3. image tends to suffer from "shadowing"

- **Liquid crystal display (LCD) Projector**

  - send light from a [metal-halide lamp](#) through a [prism](#) or series of [dichroic filters](#) that separates light into three [polysilicon](#) panels – one each for the red, green, and blue components of the video signal. As polarized light passes through the panels (a combination of a polarizer, LCD panel, and analyzer), individual pixels can be opened to allow light to pass or closed to block the light. The combination of open and closed pixels can produce a wide range of colors and shades in the projected image.

  - its benefits include

    1. good color definition
    2. high overall brightness
    3. sharper image which is preferable in high-detail data applications

  - its drawbacks include

    1. relatively lower contrast ratios
    2. LCD panels are organic and degrade over time

Please take care of the advantages and disadvantages of DLP and LCD projectors listed above

3. **Printers**

   - accepts text and graphic output from a computer and transfers the information to paper
   - different types include **3D Printers** (obviously it prints a 3D physical copy of the model), **Inkjet Printers** and **Laser Printers**

Inkjet printers	Lazer printers
environmental friendly (don't produce ozone gasses)	produces ozone gasses
produce more colorful and vivid photo	very quiet printing
very low purchase price	relatively high purchase price
not suitable for long print runs	**suitable for long print runs**
print heads are not very durable	expensive to maintain

Hence, to print a small amount of colorful and sharp images, use **inkjet**, while, to print a large amount of images (such as leaflets), please choose **laser**.

4. **Screen**

   - a device used to display output
   - different types include **liquid crystal display (LCD) screens** and **light emitting diode (LED) screens**

Advantages of LCD

Few essential advantages of the LCD are listed below:

- LCD is low cost.
- LCD is light-weight than old CRT displays.
- LCD provides excellent brightness.
- LCD has better wide viewing angles.

Disadvantages of LCD

The most common disadvantages of the LCD are highlighted below:

- LCD is not good in low-light or dim light environments because it has difficulty producing black and dark grays light.
- White saturation in LCD sometimes leads to an uneven brightness.
- LCD is built with a fixed aspect ratio and a resolution.
- LCD can provide weak or bad pixels, resulting in varying intensity or shading on the screen.

Advantages of LED

Few essential advantages of the LED are listed below:

- LED usually lasts longer, making it long-life durable.
- LED does not generate heat.
- LED is highly power efficient.
- LED usually requires less maintenance.

Disadvantages of LED

A few essential dis-advantages of the LED are listed below:

- LED is costly. The higher the screen-size, the more it will cost.
- LED has a limited range of wide viewing angles.
- LED is tough to repair when damaged.
- The repair cost is high because LED parts are costly and tough to find according to the suitable product model.

5. **Speaker 扬声器**

- outputs acoustic information

Sensors

- a type of **input** device that is used to capture data from its immediate environment
  - REMEMBER it is an INPUT device!!
- sensors are usually used in an automated system
- *refer to page 66 of your IGCSE CS textbook to find the different types of sensors used in IGCSE syllabus*

Type of sensor	Type of data captured	Example of its use
Acoustic	This type of sensors measures the level of sound in an environment.	These sensors are used in many applications that involve sound. An acoustic sensor can be used in a security system. It can be placed near a window and constantly measure the level of sound. If it captures a reading that shows a sudden increase in sound, this could mean that the window has been broken and the building may be at risk.
Accelerometer	This type of sensor measures acceleration forces. These may be static forces, such as the continual force of gravity. They can also be dynamic forces, such as those created by movement and vibrations.	These sensors are used in a wide variety of devices. Mobile phones use an accelerometer to know which way up it is faced, to automatically turn the screen on and off. They can be used to monitor for earthquakes, as they can capture the initial vibrations created. They can also be used in cars to sense when a crash has occurred, so that airbags can be inflated.
Flow	This type of sensor measures the amount of liquid, gas or steam that is flowing through or around a certain environment.	These sensors are often used in factories and sites such as nuclear power plants. They make sure that the liquid, gas or steam flows at a constant temperature through an environment, such as a pipe. This makes sure that the pipes don't rupture and break due to too much flowing through them.
Gas	This type of sensor measures the presence and concentration of a gas within the immediate atmosphere.	These sensors can be used in people's homes. They can be set to measure a certain gas, such as carbon monoxide. They constantly capture the data in the immediate atmosphere to see if too much carbon monoxide is present, which could endanger the health of anyone living in the home.
Humidity	This type of sensor measures the level of moisture in the immediate atmosphere.	These sensors can be used in farming and agriculture to make sure that the air in areas such as greenhouses has the correct level of moisture to provide the best growing conditions for the fruits and vegetables. They can also be used in places such as art galleries, to make sure that the humidity level is constant. Too much or too little can ruin paintings.
Infra-red	This type of sensor measures infra-red radiation. This type of radiation can be emitted in different amounts by both objects and people.	These sensors can also be used in security systems. This can be done in two different ways. The device containing the sensor can emit infra-red radiation and when this bounces back to the device, the readings can show from the distance it has travelled whether an intruder is present. It can also operate by capturing the infra-red radiation emitted by the intruder.
Level	This type of sensor measures whether a substance, such as a liquid, is at a certain level or amount.	These sensors can be used in a car to make sure that essential liquids, such as oil and fuel, do not get too low.
Light	This type of sensor measures the ambient light in a certain environment. It can also measure the presence of a direct light, such as a laser beam.	These sensors can be used in automatic lighting systems. Streetlights can be fitted with a light sensor that will allow the light to turn on in the evening, when it becomes darker.
Magnetic field	This type of sensor measures the presence of magnetic field that may be emitted by an object.	These sensors can be used to count how many cars pass through a certain area, for example into a car park. The car will disrupt the Earth's naturally magnetic field as it passes over the sensor and the data can be captured by the sensor.
Moisture	This type of sensor measures the amount of water that is present in a substance, such as soil.	These sensors can also be used by farming and agriculture, to make sure that the fruits and vegetables have the best level of water in the soil to help them grow.
pH	This type of sensor measures the pH level of a substance.	These sensors can be used by environmental agencies to make sure that local lakes and river are not being polluted.
Pressure	This type of sensor measures the force of pressure that is applied to the sensor or device. This could be the pressure created by a solid object, or it could be created by liquid or gas.	These sensors could also be used in a security system. They can be placed at the base or sides of an opening, such as a window or a door. When that window or door is opened, the pressure will decrease, and the system will recognise that an intruder has entered.

Proximity	This type of sensor measures how close an object is in comparison to the sensor. It does this by emitting electromagnetic radiation or an electromagnetic field and measures the radiation as it returns to see if there are any changes.	These types of sensors can be used in robots in manufacturing. They allow the robots to measure how close they are to different objects, when moving around a factory.
Temperature	This type of sensor measures the temperature of an object or substance by either directly touching it or capturing data from the surrounding environment.	These types of sensors are used in air conditioning systems. They allow the temperature of a room to be kept at a certain level.

Classic Scenarios

1. ## Checkout Stations in Shops

Inputs:

- scanner – to read the barcode
- keypad – to enter the barcode number if the barcode fails to scan
- card reader – to allow payments

Outputs:

- monitor – to show an item's description and/or price
- loudspeaker – to give 'beeping' sounds to indicate that the item has been read correctly or that there was an error in reading the barcode
- printer – to produce an itemised bill and customised vouchers

The input device can also contain a QR code scanner (for electronic payments)

2. ## Automated Security Systems

- if it asks you to detect intruders that sneak into your house :)
- **Sensors used**

1. **Acoustic sensor** 2. **Infrared sensor** 3. **Pressure sensor**

- The sensors continually send data to the microprocessor.
- Data is converted to digital form by an ADC.
- The microprocessor compares data to pre-set values.
- If an infrared (active) beam is broken, the microprocessor sends a signal to an actuator to operate a siren/flashing lights.
- If an infrared (passive) value > pre-set value, the microprocessor sends a signal to an actuator to operate a siren/flashing lights.
- If the microphone/acoustic sensor readings > pre-set value, the microprocessor sends a signal to an actuator to operate a siren/flashing lights.
- If a pressure sensor reading > pre-set value, the microprocessor sends a signal to an actuator to operate a siren/flashing lights.
- The process is continuous.