isaac computer science

Input devices

Input devices

Input devices are peripherals that allow data to be inputted into a computer system. Data comes in many different forms, and there are a wide range of devices that can be used. The input process might be manual, such as through a keyboard or mouse, or automated, such as through a sensor.

GCSE

Common input devices

There are many different **input devices** that can be used to enter data for the computer to process. Some of the more common devices, and their primary purpose, are listed below.

Device	Purpose
Keyboard	Allows a user to enter character data (numbers, letters, and symbols). It often has function keys or special purpose keys to automate common input tasks such as controlling the volume of your speakers or to switch between windows.
Mouse	Allows a user to 'point and click' to select icons, or to position the cursor on the screen.
Trackpad	Offers the same functionality as a mouse but the user controls the movement of the cursor using their fingers. It is commonly found on laptop computers.
Graphics tablet	Also known as a digitiser, this is used to create digital drawings with a Stylus.
Microphone	Captures analogue sound waves and converts them into electronic signals. Common uses include capturing your voice whilst talking to a friend online, or recording live music that can be stored digitally.
Flatbed scanner	Allows users to scan a physical document such as a photograph, handwritten note, or important letter and save it as a digital bitmap image.
OMR scanner	OMR stands for optical mark recognition. This technology is often used to input the answers or marks that a candidate has made on a multiple choice test paper.
Magnetic stripe card reader	Reads the data from a magnetic stripe on a card (eg a door access card).
Smart card reader	Reads the data from an embedded integrated circuit (IC) chip. Most retail shops have smart card readers that read data taken from the chip found on a customers bank card to enable a transaction to take place.
NFC reader	Reads the data from an NFC (near field communication) tag. A common use of this technology is contactless payment in shops. Here, an NFC reader is used to read data from a bank card or mobile phone when the two devices are close to each other.
Touchscreen	A display screen is usually listed as an output device, but touchscreens are designed so that the same device can be used to input data. The input device allows the user to use their finger or a stylus to select icons, use an on-screen keyboard, and perform navigation tasks.

Which of the **input devices** listed in the table above would be most suitable for an illustrator to make animations for online courses?

Click a button to show the answer

What is your level of confidence that your own answer is correct?

Low Medium High

GCSE **Barcodes**

A **barcode** is a means of representing data in a machine-readable form. Traditional barcodes represent data by using a set of parallel lines of varied width and spacing. Although it is hard for you to see, each character in a barcode is represented by seven equal-sized bars. These are coloured in either black or white (sometimes a different secondary colour is used) to represent the characters in the code.

Many systems use codes that include a **check digit** for validation. A check digit is an extra digit or character added to the end of a long code. It is computed by applying an algorithm to the other digits. When the long code is entered, the check digit is calculated and compared to the check digit at the end of the code. If it doesn't match, there must have been an input error. This type of validation can be carried out by software embedded within the barcode reader.

The code is usually printed below the barcode in case the barcode cannot be read. This allows the code to be entered manually.

Figure 1: A barcode

You can see in **Figure 1** that there are three pairs of longer narrow bars (on either side and in the middle of the barcode). These are guard bars, which serve as reference points for the barcode reader. Every number has a unique pattern that is designed so that it cannot be confused with any other number, even if you turn it upside down.

Most barcode readers indicate that the barcode has been read successfully, for example by sounding a beep or showing a green light.

In the figure of a barcode above. Which number is the check digit?

Click a button to show the answer

What is your level of confidence that your own answer is correct?

Low Medium High

Types of barcode reader

Barcode readers are very common; the technology is reliable and well understood. **Laser scanners**, such as those that you might find in a supermarket, are the most common type of barcode reader. Laser scanners can be small wired or wireless handheld devices, or larger fixed units. Consumer devices, such as those found at self-service checkouts, will usually have multiple lasers so that they are easier to use.

QR codes

QR codes are typically used to provide a link to a particular page on a website, or to provide a link to an email or app that holds, for example, purchase details for concert tickets or travel information such as train times and seat numbers for a journey. 'QR' stands for 'quick response'.

A QR code

A QR code can store up to 7,089 numbers or 4,296 characters. Because of the higher storage capacity, some businesses are using QR codes to replace barcodes in their business systems.

QR code scanners do not use lasers; the codes are captured and read by taking an image of the QR code, either with a dedicated scanner, or by using a camera and app on a mobile device.

GCSE

Specialist devices for people with a physical disability

Some people are not able to use a standard keyboard. A **sip/puff switch** is a pneumatic device that allows the user to control computer systems by drawing or blowing air into a sensor reader. Some sip/puff systems can be used to switch devices on and off, while some can be used to control keyboard input based on the frequency of user actions.

Foot switches are an input device that allow the user to control input to a system through a series of pedals.

Users who can read Braille may be able to enter data using a **Braille keyboard**. The keys have two raised representations of characters, the printed character and its Braille equivalent.

A Level

How to choose an appropriate method/device

There are several general factors that you can consider when choosing an appropriate device and method for data input. The main criteria are:

- Cost
- Speed
- Accuracy
- Reliability

Any method that involves a human is probably going to score poorly on all four criteria: when a human inputs data manually, the work is generally expensive, slow, and not very accurate, because humans get distracted and tired, and can make mistakes.

Therefore, whenever a human enters data manually, it is important that the data is validated to catch all possible errors. Sometimes, a verification technique, such as double entry, is also used. When you fill in a registration form, you are usually asked to enter your email address and chosen password twice. Well-designed systems will disable the functionality to copy and paste these fields so that you can't replicate an input error.

A Level

Biometric techniques

A **biometric** is a physical characteristic such as fingerprints, facial images, irises, and voice. Improvements in technology have made the use of biometric scanners increasingly common, as recognition techniques have become more and more reliable. **Biometric spoofing** is a term used to describe a method of fooling biometric scanners. Iris recognition is one of the most secure forms of authentication, because the iris is well protected by the cornea. Fingerprints can be damaged by cuts, and are easier to spoof as it is fairly easy to obtain copies.

Fingerprint recognition is often used to access phones and computers and to authorise small payments. Many airports are now using **iris recognition** as a major part of their security systems.

An emerging use of biometrics is that of **voice recognition**. Our voices have unique characteristics, such as length of the vocal tract, pitch, and accent. Many banks and insurance companies now use voice recognition to identify customers.

With all biometric systems, it is important that users opt in and consent to the storage and processing of their personal data. HM Revenue & Customs was recently instructed to delete over 5 million recordings for their 'Voice ID' service, when it was deemed that they had not been collected lawfully.

A Level

Sensors

There is a wide range of control systems in which sensors act as analogue inputs. The analogue signal is converted to digital form (for processing) by an analogue to digital converter (ADC).

Many systems make use of sensors, including robotics systems, building control systems, and flight control systems, for example. There are many different types of sensor. For example, mobile phones can have a wide range of sensors, including accelerometers, gyroscopes, magnetometers, GPS receivers, barometers, thermometer proximity sensors, and ambient light sensors.

A Level

Digital cameras

Digital cameras are used to capture images. Most mobile phones now have digital camera functionality, although professional photographers and keen amateurs often prefer to use dedicated cameras.

When you take a picture on a digital camera, you open a shutter to allow light to enter the camera through the lens. The lens focuses the light onto an image sensor, which is an array of millions of photosites (light-sensitive elements). The 'picture' is thus broken up into millions of pixels.

The photosites measure only the intensity of the light. To determine the colour of each pixel, a 'Bayer filter' is used. This sits above the image sensor and provides an array of red, green, and blue filters, one for each photosite. There are twice as many green filters (as red and blue filters), as this matches the colour sensitivity of the human eye.

Use of the filter means that only the intensity of red, green, or blue light is measured at each photosite. The final value for each pixel is derived from its own colour intensity and those of its immediate neighbours through the application of a **demosaicing algorithm**. Such algorithms are closely guarded commercial secrets, as they will ultimately determine the quality of the final image.

The camera has an image processing engine that carries out the demosaicing stage. It includes an analogue to digital converter that converts the analogue signal into binary form. At the end of the process, the colour of each pixel is represented by a numeric code; your digital photograph is effectively an extremely long string of numbers.

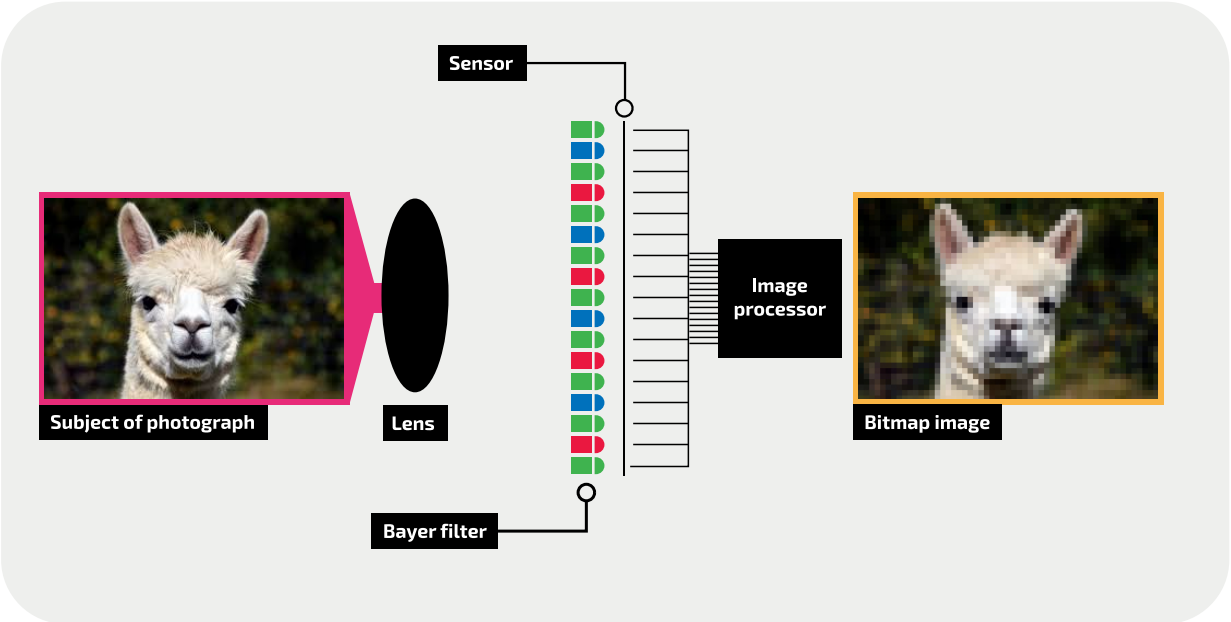

Figure 2: Image capture

Derivative work based on original by Beko, CC BY-SA 4.0

The image processing engine in some cameras (and in most mobile phone cameras) will automatically compress images to JPEG format. The amount of compression can usually be set by the user, and a higher compression rate will allow more images to be saved on the camera's internal storage.

Image quality is influenced by the size and nature of the sensor. Larger image sensors have more photosensitive points so are able to capture images with greater fidelity. There are two different types of sensors: CCD (charge-coupled device) and CMOS (complementary metal-oxide semiconductor). You can find many arguments in support of each but, in essence, the more expensive CCD sensors produce higher-quality images. However, CMOS systems use less energy, so are more popular on mobile phones and other devices that use a lot of power.

A Level **RFID**

RFID (radio frequency identification) allows data to be transmitted wirelessly over radio waves.

There are two parts to an RFID system: a tag and a reader. Use of radio signals means that the system does not require a line of sight between the tag and the reader.

RFID tags are made up of an antenna, for receiving and transmitting the radio frequency signals, and a chip, which processes the signals. Each tag has a unique identifier and will often store some additional data in a non-volatile memory cell.

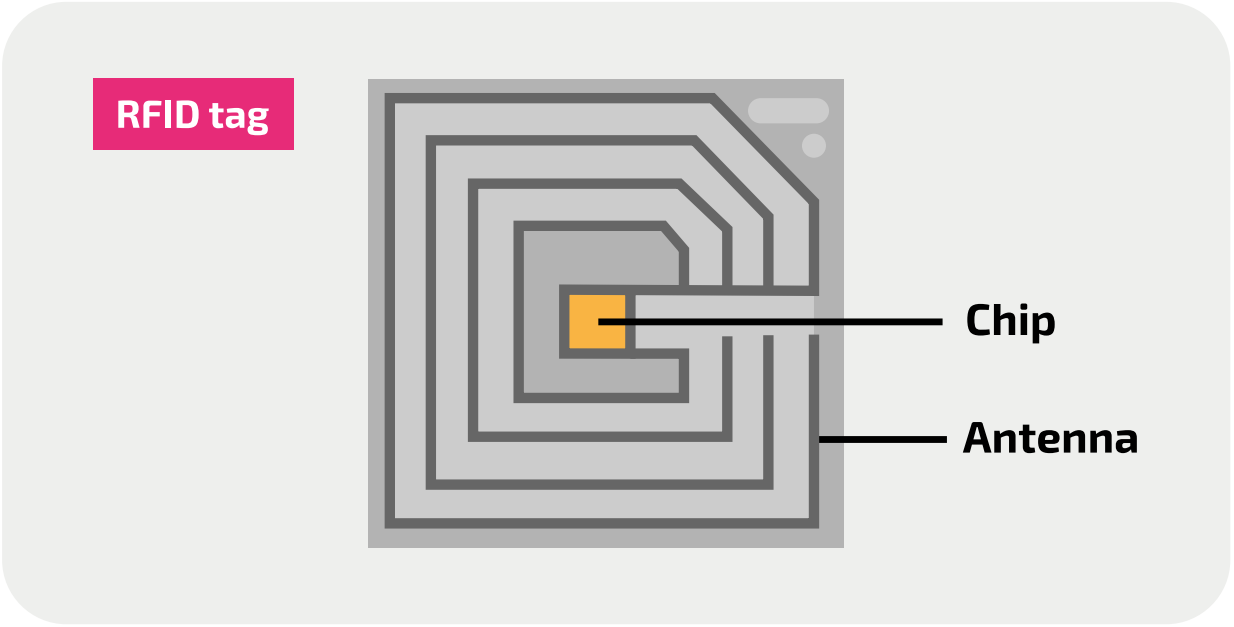

Figure 3: RFID tag
Midnightcomm via Wikimedia Commons, [Public Domain]

The RFID reader transmits an encoded radio signal to interrogate the tag. The tag receives the message and then responds with its identifier and any other stored data (for example, a stock number or product ID). Readers can process multiple tags at the same time as each has a unique identifier.

RFID tags can be read-only or read-write, and come in many physical forms. For example:

- They can be incorporated into tiny sticky 'labels' that can be concealed within products or inserted into chunky plastic enclosures that can be attached to items for sale
- They are often embedded in employee and student ID cards that are used to open doors and car park barriers
- They are used in many library cards and on transport systems
- They are commonplace on production lines and in warehouses
- They are used to track the movements of farm animals, and pet owners are often encouraged or required to have their pets tagged for identification purposes; a tiny tag, the size of a mobile phone SIM card, is inserted into the fleshy part of the pet's neck and can be read by a handheld reader

Passive devices do not contain a power supply. Instead, the device is powered by radio energy transmitted by the reader. The antenna collects the energy from the transmitter to activate the chip. The range of a passive system is up to 1 metre, and some systems require the reader to be very close to the tag.

Active systems have a small battery within the tag, and the device will transmit its identifier at regular intervals. Depending on the power supply, the range can be up to 200 metres. Active RFID devices are commonplace in shops, where battery-powered tags are secured onto items. The tags are deactivated or removed when the goods are paid for. A reader is situated at the shop's exit and an alarm is triggered if it detects an active tag when a customer leaves the shop.

A Level

Barcode readers - operation

Figure 4: Barcode

To read the code, a light from a laser illuminates the barcode. More light is reflected from the white areas than from the black bars. The reflected light is captured by one or more photoelectric cells that generate a set of electrical pulses that correspond to the black and white stripes in the barcode. These pulses are processed and converted to a binary number that represents the code.

Most barcode readers indicate that the barcode has been read successfully, for example by sounding a beep or showing a green light.