Input and output Systems

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Keyboard

- Each key-press sends on byte
  - Each key is numbered
- Possibly two bytes – one when pressed, one when released
  - E.g. shift key
- Computer has a table mapping key numbers to characters
  - Multi-lingual support

Each key press sends one byte of information to the computer. These bytes do not necessarily contain ASCII codes - the IBM-PC has its own quite separate key-numbering scheme for example. Some keyboards send one signal when a key is pressed and another when it is released. This allows the computer to determine whether a shift key is depressed at the same time another key is pressed. It also allows it to implement features such as repeatedly generating input as long as a key is depressed. Software in the computer maps key-codes to ASCII codes. This mapping may not be fixed, thus allowing different mappings for different languages.

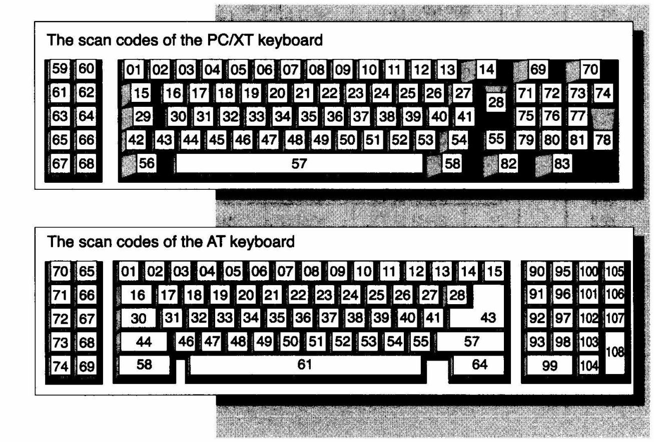
Bytes from keyboard arrive at Keyboard interface, which stores byte(s) and generates interrupt. When the CPU responds to the interrupt and runs the ISR (interrupt Service Routine), the byte(s) are read from the interface, translated by using the current input character set, and stored for use by the program receiving the input.

Keyboards

Keyboards

•transmit an 8-bit *scan* code for each key on the keyboard related to the physical position of the key

•translated to input character via currently defined input character set



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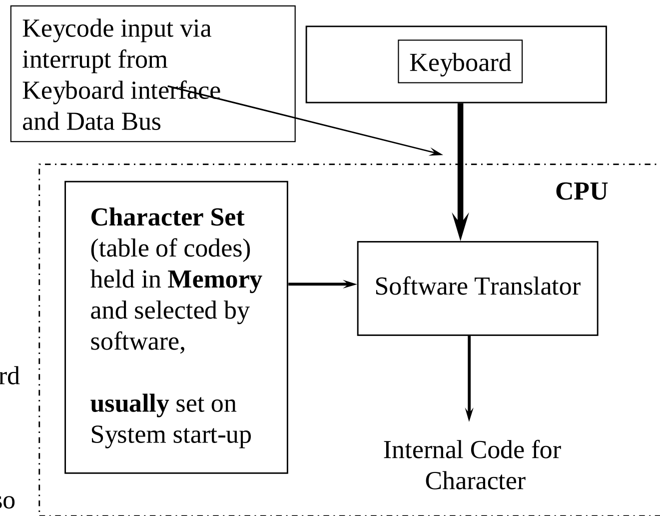
Keyboard Input on an IBM PC -compatible system



Word Processors, e.g. Word and WordPerfect, allow characters from other character sets to be embedded in documents, so that they can be output.

Mouse

- Sends 3 bytes every time mouse moves (say) 0.01 inch
  - Vertical, horizontal, button state
  - Computer moves mouse pointer proportionately
- Computer knows what mouse pointer is currently pointing at
  - Can implement correct action when button is pressed

A mouse sends signals to the computer at intervals. Typically, each signal consists of three bytes and says how much the mouse has moved (up-down and sideways) since the last signal, and what is the current state of the mouse buttons (pressed or not). Typically, signals are sent every time the mouse moves a certain distance (say 0.01 inch), sometimes called a "mickey".

Software in the computer interprets these signals and reflects them in positioning a pointer on a video display. By keeping track of where the pointer currently is, the computer can respond correctly to the mouse buttons. For example, if the pointer is currently aimed at a menu item, pressing a button will select that item.

Various methods are used to determine how the mouse has moved, ranging from the purely mechanical to the optical.

Again, mouse activity (movement, clicking keys) sends bytes to the mouse interface, which generates interrupts. The mouse activity is translated by the Operating system software that is managing the computer display.

Monitors

- “Cathode Ray Tube” (CRT) to display text and graphics.
- Image built up a line at a time
  - “Raster scanning”.
- Lines drawn on the screen by a beam of electrons.
- Switching the beam on and off produces light and dark areas.

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A monitor uses a “Cathode Ray Tube” (CRT) to display text and graphics. The image is built up a line at a time - a process known as “raster scanning”. In a CRT, the lines are drawn on the screen by a beam of electrons. Switching the beam on and off as it draws produces light and dark areas. A colour screen will have three electron guns and three coatings on the screen designed to fluoresce in red, green and blue. Some monitors are geared purely to the display of text. However, the great majority used on today’s PCs will display text and graphics. It is these that we describe below.

Bit-mapped displays

- Can show pictures as well as text.
- Screen viewed as a series of dots called "pixels".
  - Low resolution screens 640 x 480 (= 300K) pixels
  - High resolution screens 1280 x 960 (= 1.2M).
- Image to be displayed is stored in "video RAM"

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The screen of a bit-mapped monitor can be regarded as a series of dots called "pixels". Low resolution screens might have 640 x 480 (= 300K) pixels, high resolution screens 1280 x 960 ($\cong$ 1.2M). For a monochrome screen, each pixel will either be on or off. In this case, the video RAM contains a bit-map with one bit for each pixel. (Hence, 37.5K bytes for low resolution, 150K bytes for high resolution). Colour is handled by allocating several bits to each pixel. The more bits used the finer will be the gradations of colour that can be represented; 8 bits gives 256 colours for example. "True" colour requires 8 bits for each of the three colours, so a true colour 1280 x 960 screen requires about 3.5 Mbyte of video ram.

When text characters are to be displayed, the computer must select which pixels to switch on to make the required shape. This involves the computer in knowing about fonts and so on. The display hardware simply scans the bit-map and generate a signal to switch the corresponding pixels on and off.

Graphics cards

- PC or scientific workstation
  - Monitor is an integral part of a computer
  - Video RAM plus electronics to produce video signal are on a “graphics card”.
- Video RAM is accessed by the processor via the bus (memory mapped)
- Graphics card may have support for block moves, scrolling etc.

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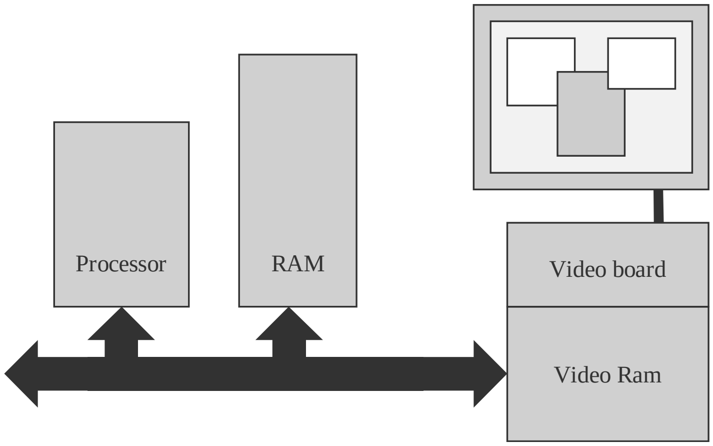
Clearly, a lot of video RAM is required for colour bit-mapped screens and a lot of processing power is required in order to manage it. Modern systems provide a separate (graphics/video) processor to help with this. This processor helps with operations like “scrolling” a section of text up the screen which involves copying (or otherwise re-mapping) a large number of bits into new positions. This leaves the main processor free to pursue other tasks. The graphics hardware runs autonomously updating the display with data from the Video RAM as required: this takes a lot of work off the main processor.

Display system



Where a monitor is an integral part of a computer (as in a PC or scientific workstation), the video RAM and the electronics to produce the video signal are either placed on the main processor board or are packaged together on a separate card often called a “graphics card”. Normally, the video RAM is accessed via the bus (see slide).

Video RAM

- Monochrome - each pixel will either be on or off.
  - Video RAM contains bit-map - one bit per pixel.
- Colour - several bits per pixel.
  - 24 bits per pixel for "true colour"
    - 1280 x 960 screen => 3.5 Mbyte of video RAM
- Display hardware scans video RAM and generates signal to drive display