Computer Systems

UD 03. HARDWARE COMPONENTS

External components – Graphic card and monitor

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CFGS DAW

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Licencia

Nomenclatura

A lo largo de este tema se utilizarán distintos símbolos para distinguir elementos importantes dentro del contenido. Estos símbolos son:

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1. GRAPHIC CARDS. BASICS

In most computers, we represent images. The component which is responsible for interpreting the graphic data that come to the microprocessor and transform them into a signal that can understand the monitor is what is usually called graphic card or graphic adapter.

Today we can find this adapter:

- Integrated into the chipset: frequent office PCs, small and portable PC. In general, any system that does not require a lot of graphical power.
- Integrated into the CPU: some processors have included the adapter. This provides advantages such as lower consumption, lower latency and lower price, but without a great 3D performance.
- Integrated motherboard. Not to be confused with the integrated into the chipset. This is a separate chip. They have the disadvantage that power is often limited. Usually a widely it used on computers that require little graphics requirements such as servers.
- Expansion cards: the usual graphics cards. The reason for its use is to connect more monitors or to increase performance.

> 📣 Current graphics cards have a higher complexity of the rest of the PC. For example, a Core i5 with 4 cores has 750 million transistors, but a graphics chip can have between 1500 and 2000 million transistors and all of them in a dedicated way. The problem is that life is very limited.

1.1 Screen resolution

The screen resolution is the number of points that form the image that will be displayed in the monitor expressed as "horizontal dots x vertical dots" for example 1280x1024. The greater the resolution will be the detail that will be on display. However, the chosen resolution should be consistent with the size and type of monitor:

- If a very high resolution is used objects look very small in a very small monitor.
- LCD monitors have a fixed dot matrix called native resolution, these monitors can represent other than native resolutions but with much poorer quality.
- Any graphics card can handle very high resolutions in 2D and 3D static (photos), but in dynamic 3D (games) any increased resolution is a sudden drop in performance to unbearable limits.

In general, the higher the resolution the image quality will be higher, offer a greater field of work and also, if the monitor is large, the view is less tiring.

Each resolution has a certain aspect ratio (aspect ratio) is the ratio of the horizontal size and vertical size of the image, which should be identical to the display device. The most common aspect

ratio is 4: 3 (1024x768) and 5: 4 (1280x1024), commonly called square or 16: 9 (1366x768) and 16:10 (1680x1050), the panoramic called.

> The calculation made to relate the resolution with the aspect ratio is simply to divide 1024/768 = 1.33 = 4/3

1.2 Number of colors

Also called color quality or color depth. It is the number of different colors that can reach each of the screen pixels. It is usually expressed by the number of bits. Nowadays, the minimum is 65,536 colors (16 bits), although it is usual 16.7 million colors (24 bits), also called true color or even 32 bits.

1.3 Video Mode

It is the combination of the above parameters (resolution and number of colors) that are interrelated: higher resolution, less colors and vice-versa. The parameter that limits video modes is the amount of video memory.

1.4 GPU

GPU (Graphics Processing Unit) is a processor such as CPU, but specifically dedicated to graphics processing; its task is to reduce the workload of the central processor, being optimized for floating point computing, which is the type of data that is handled more 3D operations.

GPUs are able to perform certain operations denominated graphics primitives, as the drawing of certain basic shapes: rectangles, triangles... as well as the pre-processing and post-processing for high quality images like anti-aliasing, accelerating the screen representation of the images much more than if these were made via software.

Today the manufacturing market's GPU graphics cards for PC is focused on two companies: nVidia and ATI. That is why the first decision when choosing graphics card is to chose one of them.

1.5 Video Memory

Video memory is memory dedicated solely to the use of the graphics card, the place where information of the calculations performed by the graphics chip is stored. Formerly the only function was to serve video memory frame buffer (storage space for the image before moving on to the monitor).

Today in graphics cards with 3D functions, things change. Memory is used to store data from multiple additional functions, such as the depth of the image points (ZBuffer), textures, images to apply anti-aliasing, etc.

Nowadays, the most normal is found between 1GB and 4GB of GDDR5 memory.

> If the dedicated memory on the graphics card it is over, RAM memory is used as video memory, making the 3D performance much lower.

1.6 Drivers

To handle the graphics card and take full advantage, a OS-dependent software called device driver is required. Drivers can affect much the performance or operation in general. When you buy a

graphics card is important to check the support that the manufacturer gives the OS we intend to use.

> It is the manufacturer who must provide the drivers of the graphics card, although almost always (but not always) generic drivers can be used by the chip manufacturer.

1.7 Connectors

1.7.1 Internal connectors

Nowadays, the connection between the MoBo and the graphic card is always with a PCIe slot.

1.7.2 External connectors

Graphics cards have used various types of connectors for the cable to the monitor. The first was the called *D-sub 9.* Later, the VGA standard gave way to mini *D-sub 15-pin,* known as VGA connector. This connector is analog, which means that the images calculated by the graphics chip digitally must be transformed into analog values for transmission which loses some quality.

Figure 1. VGA connector

The arrival of the LCD monitors, which are already digital, led to the introduction of DVI connector. There are three types:

- DVI-D: with 18 or 24 pins that supports only digital signals
- DVI-I with 22 or 28 pins that supports digital or analog signals
- DVI-A: 16-pin connector that supports only analog signals

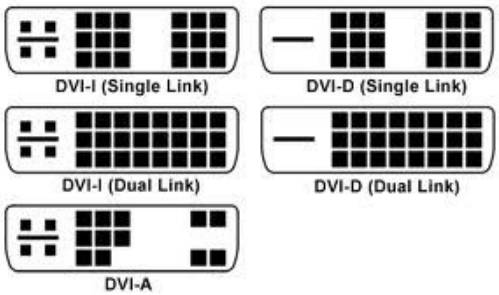

Figure 2. DVI connectors

The different number of pins depends on whether the connector is *Single Link* or *Dual Link*. The former has a sufficient bandwidth to transmit signals up to 1920 by 1200 at 60 Hz, while the second is used to transmit more information needed for example for 3D visualization.

> Today any card features *Dual Link* connectors but be careful with the type of cable used in the connection, since in many cases remains *Single Link.*

Lately, is becoming more usual the HDMI connector, widely used in HD TV. Both DVI and HDMI are electrically compatible so that it can be passed from one to another with a simple adapter, but the second has the advantage that it can transmit video plus sound.

Figure 3. HDMI Connector


Figure 4. Display Port connector

Besides HDMI and DVI, there are other solutions as *Display Port*, widely used in Apple Computers. It is also electrically compatible with HDMI.

1.8 Graphic libraries

An API is an interface for application programming. We could say that is a set of functions gathered in libraries that help for programming application because they offer many standardized methods to perform operations. There are API for multiple facets, but in this case we focus on the graphics context.

The two most important graphics APIs are *OpenGL* and *DirectX.*

> Actually, *DirectX* incorporates libraries for more things like audio. The part of *DirectX* dedicated to 3D graphics is *Direct3D*.

OpenGL is an open standard platform, however *DirectX* is intended for Microsoft OS, *Windows* and *XBOX*. Microsoft just includes support for OpenGL systems, although it is relatively simple to install libraries from the Internet. Partly because of this, in terms of games, *DirectX* is settling as standard, however in technical applications OpenGL library remains successful.

Supporting a library or other or both of them, and in that particular version, implies that part of that library functions can be made via hardware, with the significant improvement in performance that that implies. In other words, when a graphics card is manufactured for a particular *DirectX* version (for instance), it will not be able to use features from higher versions.

2. MONITORS BASICS

According to the technology used to represent images, we can say that there are several types of monitors:

- CRT: they are the classical big monitors. They are called CRT because they have a Cathode Ray Tube.
- LCD (Liquid Crystal Display) it is based in the technology that was used in calculators. Today also are called TFT monitors.
- Plasma screens: they have very good visual characteristics but are expensive (now less), low life and much power consumption.
- Projectors: are widely used in the professional field for presentations.

The projectors are expensive by the projection lamp. This is a component that we must be protected, because life is marked by the use and heating.

2.1 Monitor size

Monitor size is measured in inches and refers to the size of the diagonal of the screen. This number coincides almost exactly with the diagonal only on flat screens. In the CRT, size is less than the diagonal because part of the tube is not used to be covered with the box. The difference between nominal size of a CRT and its useful size is usually 6%.

> 1'' = 2,54 cm

2.2 Screen resolution

The resolution is the number of pixels that can represent the monitor given as horizontal dots x vertical dots. Thus, a monitor with a maximum resolution is 1024 x 768 may represent that resolution and lower resolutions.

The higher the resolution, elements will be more defined, the quality will be higher and more expensive it will be. However, the resolution must be appropriate to the size of the monitor. Certain objects are represented with a fixed number of pixels, so if we increase the resolution this object will draw smaller.

CRT monitors offer much flexibility on the issue of resolutions because they can reach a very high resolution, but also represent very well lower resolutions.

However, this does not happen with the LCD. An LCD monitor has a fixed dot matrix (a certain amount of pixels) called native resolution. Any other lower resolution use a non-integer number of pixels, so the image quality will lose quality. And, of course, they can not display resolutions higher than the native.

Lately the term HD and UHD appears on the monitors. When it is said that a monitor is FullHD its vertical resolution is at least 1080. When it said that a monitor is 4K UHD its vertical resolution is 2160.

> Sometimes, monitors have labeled with HDp or HDi. The difference between *p* and *i* indicates whether the display method is interlaced (i) or progressive (p). For interlaced in each time instant only one set of lines (for example the pairs) are shown and the rest in the next (odd).

2.3 Pixel density

Pixel density refers the number of pixels per inch. LCD screens have a density of pixels which is usually between 85 and 102 dots per inch (dpi), but there are more advanced that exceed 120 dpi.

> In general, manufacturers give the horizontal density, which is calculated by dividing the horizontal pixels by the horizontal dimension. Usually, we only have the size of the diagonal, so it is necessary to calculate the horizontal dimension by the Pythagorean Theorem and the aspect ratio.

2.4 Aspect Ratio

The aspect ratio is the ratio of the horizontal size of the screen and the vertical size. Historically it has been 4:3, that is, almost square monitors (per 4 units of measurement in horizontal, 3 vertical)

But human have a stereoscopic view (panoramic), that is, its field of view is elongated, very close to the ratio of 16:9. Some years ago, with the emergence of multimedia information, these formats have begun to be the most common in both, monitors and television screens. The most commonly used formats are: 16: 9, 16:10 or 15: 9.

> The aspect ratio is closely related to the screen resolution. Although, at the beginning any resolution can be assigned to any screen, there are resolutions suitable for each of the formats.

3. LCD MONITORS

The liquid crystal technology is based on a property of the family of materials of the same name that under normal conditions the light passes through following a certain way, but if we apply electrical charges at the ends of the crystal, the molecules rotate and cause light to take another path.

The application of this technology only allows visualization of a color. To provide images in various colors the solution is to divide each of the cells of LCD (each pixel) in three sub-cells (or sub-pixels) and apply different color filters to each so that red light is generated, (red , R), green (green, G) and blue (blue, B), from which any color can be generated.

There are 2 types of LCD screens:

1. LCD passive matrix. In this case every point has to keep itself color until it was cooled again. This causes such monitors with matrix have little bright screens.

2. LCD active matrix. It adds one more layer to the mechanism. This layer consists of millions of transistors (one for each sub-pixel) each of which provides a capacitor switch serving to control and maintain the loading of each sub-pixel. So livelier and faster response times images are achieved. These monitors are also called flat panel displays.

3.1 Response Time

Depending on the monitor use, the response time can be one of the most important parameters. The response time is the time (measured in milliseconds) it takes for a pixel to go from one state to another. The shorter the time, it is less likely that a kind of trail appeared (they are a kind of ghosts who appear behind the images) and especially affects playing video games, movies and sporting events.

3.2 The panel

The panel is one of the most important issues when choosing a TFT monitor.

There are 2 types of panel technologies:

1. TN are the most common, each pixel can represent 262,144 colors: RGB (6 bits per color).

2. IPS or PVA: are better than TN except for refresh rate and price (they are considerably more expensive), of which the best known are IPS (and his family, as HPS and SPS that are the same as IPS). His sub-cells are 8 bits, thus allowing up to 16.7 million colors.

3.3 Brightness and Contrast

These are two of the most wanted features when people are choosing a monitor.

Brightness is measured in *candelas* (cd). The greater or lesser brightness will allow us to use the monitor will effectively whatever the lighting conditions of the environment.

Meanwhile, the contrast is the value that indicates the ratio of light intensity between the brightest white and the darkest black that the monitor can display at once. A more contrast colors look better.

Unfortunately, TFT monitors have permanently on the backlight, so they can not avoid to let out some of that light source, especially if the brightness is too high.

3.4 Lighting: CCFL or LED

We just say that everything TFT monitor has a white light in the background. Formerly that light was fluorescent lamp type CCFL, but currently this lighting is increasingly replaced by LED technology. Advantages of LED: the power consumption and the heat are lower and the color reproduction is better.

4. TOUCH DISPLAYS

In general, to make touch devices the idea is to add, in front of a TFT, a device that reacts to any physical changes produced by making the user pressure

There are several ways to implement this technology:

1. Resistive. The touch device is formed by several conductive layers (which conduct electricity) separated by different points distributed in a matrix. Pressing the layers together and producing electrical conduction point being determined by measuring pulse voltage. This type of display can be used with gloves and all kinds of objects. They are the cheapest.

2. Capacitive. The position is determined by the pulsation measuring the electrical capacitance of the user and the variations to interrupt this current. Normally only they react with the bare finger and is very resistant to scratches.

3. SAW (surface wave acoustic). It consists in sending ultrasound waves by the crystal surface. The user pressing absorbs some of the energy of the wave, and a sensor detects that loss calculating not only the position but also the pressure intensity.

4. Optics. Uses cameras that scan the screen and software that detects and interprets when and where pulsation occurs.

5. ERGONOMICS

Ergonomics is the study of biological and technological data applied to problems of mutual adaptation between man and machine. That is, in other words, how to improve human-machine relationship so that it is least harmful. It affects many of the external components, but may see one of the most important is the monitor.

Very briefly you can give the following pieces of advice:

- It is important to be well seated. Recommended that the chair is rotating.
- Good lighting and if it is naturally better. It is better to have the natural light on the left if you're right-handed (on the right if you're left-handed), never behind or by either front.
- At least the distance between the user and the monitor has to be 50cm and recommended 80cm.
- While you are working with the computer, you should raise from time to time, and change the view to something that is far away.

6. ADDITIONAL MATERIAL

[1] Glossary.

[2] Exercises.

[3] Questionary.

7. BIBLIOGRAPHY

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