Macintosh II: Video Overview (1 of 3)

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TOPIC ---

This is the first part of a three-part article describing how the Macintosh II produces video.

DISCUSSION --

HOW DOES THE MACINTOSH II PRODUCE VIDEO?

Digitized video is a rectangular array of pixels mapped into RAM. This is called bit mapping and it's used by both Macintosh and Apple II computers. At one bit per pixel for black and white images, bit mapping uses up lots of memory. Color images are even more memory-intensive, because each color pixel is defined by a group of bits. A Macintosh II display contains 307,200 pixels (640 x 480), requiring a minimum of 37.5 kilobytes of memory for a monochrome display. A color Macintosh II uses up to eight bits per pixel, and may require up to 300 kilobytes.

The Macintosh II's video card generation circuitry works independently of video memory updates from changing graphics. The signal that controls the speed of the image display process is called a pixel clock, which is produced by an oscillator on the card. Once a graphic image has been stored, it continues to be displayed at the speed of the vertical refresh scan rate: 66.67Hz on the Macintosh II video card. A full screen of video information (307,200 pixels) is displayed 66.67 times per second. This means it takes only 15ms to display an entire screen. A horizontal line (480 pixels) takes only 1/35,000 of a second or .029ms (35KHz scan rate).

The Macintosh II video signal is a linear electrical stream converted from the pixel information stored in the Macintosh II Video Card's RAM. This RAM is called a frame buffer. These bits represent the collective dots that make up the picture, hence the term bit-mapped graphics. A single bit can represent a single dot of the picture. For example, a bit value of 1 might signify a white dot, while a 0 represents a black dot. More than one bit is needed to represent the dots of a color picture -- a color dot might use eight bits to represent a single dot of a video picture.

Graphics on a Macintosh II are organized into consecutive bits (1, 2, 4, or 8) used to represent pixels. This is a chunky format, also known as pixel mapping. Other possible formats include adding different planes of bits. Each plane is a representation of the screen with a one-to-one correlation of bit to pixel. Adding the bit planes allows a pixel to have an increased value to represent variations in color (planar format). A combination of the two techniques, known as chunky planar, can also be used. An example of such a combination would be to use three separate bit planes or video maps, each with values for red, green, and blue intensities to be combined into the color value for each pixel. The Macintosh II Video Card uses an eight-bit look-up table and chunky format. In binary, a string of eight bits can represent 256 different values: 0 through 255. This allows 256 intensities of red, green, and blue to be defined for each pixel. The 24-bit combinations of 8 bit red, 8 bit green, and 8 bit blue available on the Macintosh II video card generate 16.8 million possible colors (2 to the 24th power). Of the more than 16 million colors, 256 are selected and stored in a look-up table. Colors are then requested by software, and the closest matching color within the table of 256 is selected and stored in the frame buffer for conversion into a video signal of a particular pixel within the picture.

CREATING A VIDEO SIGNAL

To create a video signal recognizable by an analog RGB monitor, each of the 'dots' is converted by the Video Card into a time period of electrical strength by a device known as a digital to analog converter (DAC). The analog signal, or video signal, is a series of picture dots converted into time periods of varying electrical amplitude. A monitor or television is able to convert the signals into an exposure intensity of its phosphor dots known as pixels by a constantly moving electron beam. The beam is controlled by deflection, or sweep, circuits, which produce either electrical or magnetic fields that deflect the beam to hit the screen phosphors and cause them to give off electrons and thus glow. The persistence of the phosphor pixels after exposure to an electron beam creates the glowing dots of the video screen. If the persistence of the phosphor were very short, the video picture might show only a single dot moving across the screen as the electron beam sweeps down the screen, one horizontal line at a time. If the phosphor decay were not equal to the timing of the beam, a flicker may appear where the phosphors have decayed to black, or a ghosting image when the decay rate is longer than the scan. In the case of a color signal, instead of having one beam to turn on pixels, three beams are used. Each picture dot is made up of three pixels: red, green, and blue. Each of the three beams fires only on a color pixel assigned to it. The blocking of the separate beams is done through a shadow mask or aperture grill. This is a metal mask made up of wires on the Apple High Resolution Color Monitor. The spacing between openings in the shadow mask is known as the grill pitch. The size of the grill pitch enhances the sharpness of the image. When the green beam fires, it is only on the green phosphor dots. The same situation is repeated for the colors red and blue. The strength of the beam is controlled by the signal magnitude received while firing on a pixel and produces the intensity of the color. A color dot might contain all three pixel colors at varying intensities.

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