

Re: [OT?] Refresh rates for LCD screens?

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- *From:* davem@xxxxxxxx (Dave Martindale)
 - *Date:* Tue, 13 Sep 2005 15:26:09 +0000 (UTC)
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jg.campbell.ng@xxxxxxxx writes:

>My model for CRT displays has a display processor scanning through
>image pixel memory cells in raster order and sending grey level values
>through a digital to analogue converter to produce a voltage which
>somehow modulates the flow of electrons from an electron gun onto
>phosphor painted on the rear surface of the front of the tube; scan
>signals are generated accordingly. For colour, multiply everything by
>three and include shadow masks and red, green and blue phosphor
>patches.

>What is an equivalent refresh model for LCD screens? Assume analogue --
>though I might need an exact explanation of the difference between
>analogue and digital in this context.

In the case of LCD screens, there is local memory *in the LCD controller* to remember the state of every pixel in the screen. Because of this, there are two parts to "refreshing" an LCD screen: getting the data from the computer frame buffer (graphics card) to the LCD controller, and then driving the LCD panel itself.

The first part of the process is done *as if* the LCD was a raster device. The pixel data is sent from the computer to the LCD controller in row/column raster order just as if it was a CRT. If you're using an analog connection between computer and display, the graphics card actually generates analog RGB and sync signals just as if it was driving a CRT – it has no way of knowing the display is actually an LCD. Then the display controller generates local clock signals locked to the incoming analog video, and converts the signal back into digital form before storing the pixel data in the LCD controller memory. If the frame buffer pixel clock and the LCD controller pixel clock are not the same, you can end up with pixel jitter artifacts.

On the other hand, if you use a digital (DVI) connection between graphics card and display, the pixel data is transferred in digital form, with no noise introduced by D/A and A/D conversion, and without wasting time for horizontal and vertical sync and blanking periods. This is more efficient, and avoids the need for the digitizing circuitry in the display.

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Either way, once the pixel information is in the LCD controller, the controller then uses it to modulate individual pixel cells in the LCD panel itself. This happens at a frequency that is determined by the controller and panel's needs, and it's not necessarily synchronized with the incoming video.

>I know that LCD screens have a 'native' resolution, i.e. that each
>screen pixel corresponds to a single transistor or diode.

Yes. But many LCD monitors contain internal resampling hardware that will accept an incoming signal at a wide range of resolutions and then resample that to the actual display resolution. The image tends to lose some crispness when you do this, so it's generally better to operate at the native resolution.

>Do we still have raster refresh? I guess flicker and tearing do not go
>away when we have an LCD screen.

The refresh is raster as described above.

The light output from an LCD is continuous; it doesn't come in bright pulses as the electron beam sweeps over the phosphor like a CRT. This means that LCDs don't flicker if they are updated slowly from the computer; 60 Hz refresh flickers visibly on a CRT but not LCD.

On the other hand, tearing is caused when a single displayed image on screen comes from two different points in time. To avoid this with a CRT, it's simply necessary to have the video controller swap buffers (between the previous and next rendered frame) during vertical retrace so each displayed frame comes from a single point in time. With an LCD, there's the additional delay between display controller update and screen update which can complicate things.

>Another question. If 25--30 Hz is good enough for television or movies,
>why the need for 70--85 Hz refresh on computer screens?

With a flickering light source, we can see flicker up to about 72 Hz when the light is very bright, dropping below 50 Hz when the light is dim.

Television uses a 25 or 30 Hz complete frame rate, but the image is sent in interlaced mode: all the even scanlines are sent in the first 1/50 or 1/60 second "field", followed by all the odd scanlines in a second field. CRTs display this signal in the same way, so the screen is actually refreshed at 50 or 60 Hz; it just isn't quite the same data each time. As long as there are no drastic changes between two adjacent scanlines (and good TV is filtered so there is not), we don't see flicker.

Movies are shot at 24 FPS, but the projectors use a shutter that

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interrupts the light either 2 or 3 times per frame, so the actual flicker rate on screen is 48 or 72 Hz. 48 Hz is most common, and works well in most theatres where even the brightest white in the image is not that bright in absolute terms, and most of the image is much dimmer. It's common to see a little bit of flicker in the brightest portion of the image only. 72 Hz shutters are better in small theatres with particularly bright images; that pretty much eliminates visible flicker.

But computer screens aren't interlaced (anymore), and they are operated at high brightness, so you need about 72 or 75 Hz refresh rate to avoid visible flicker.

>Plus, maybe I should ask whether the answer for LCD will do also for
>TFT and plasma?

TFT is just one LCD panel technology; it's not a separate type of display. Plasma displays are likely very similar to LCDs when it comes to the computer-display controller connection. Driving a plasma panel takes very different voltages and current from driving an LCD panel. LCDs use very low voltage and current to change the polarization state of the liquid crystals, while the light comes from a separate backlight and two polarizing sheets actually absorb or pass light. Plasma panels emit light directly from each pixel cell.

Dave
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• *Follow-Ups:*

- ◆ *Re: [OT?] Refresh rates for LCD screens?*

◇ *From:* jg . campbell . ng

• *References:*

- ◆ *[OT?] Refresh rates for LCD screens?*

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