RTT TECHNOLOGY TOPIC
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3 G Content Capture

Our March Hot Topic covered DISPLAY TECHNOLOGIES **–** this month's Hot Topic looks at image capture/content capture devices.

Most early concept products for 3G include a display **and** in-built camera. In the longer term, displays may become 2 way devices, ie take pictures **and** show pictures – many of the processing elements are common to both functions. For the time being however, image capture and display devices are being treated as individual items, separately positioned in the appliance.

Our theory has always been that a substantial part of internet value is 'edge inwards value' – subscriber generated 'egocentric' content, hence the importance of 'content capture'.

Content capture includes image and video streaming. As with displays, in any imaging system there is a fundamental trade off between resolution, colour density and frame rate.

As an example, digital cameras today typically give an option of two imaging modes, video (at varying frame rates) or single shot images (at varying resolution).

Note that image capture bandwidth directly determines the need for localised (appliance resident) **and** centralized (network resident) memory bandwidth and local area and wide area delivery bandwidth.

Basically there are presently two imaging options, charge coupled devices and CMOS image sensors.

Charge coupled devices rely on the transfer of a capacitive charge induced by optical energy (light) falling on a silicon substrate – (silicon is sensitive to light between 400 nm and 1200 nm which includes the visible spectrum).

Charge coupled devices can provide very high resolution – in the order of Megapixels per image and can be made to deliver extremely low fixed pattern noise. They are used typically in digital cameras where high resolution is a requirement or for very low light applications – night time surveillance for example, where fixed pattern noise constitutes a significant percentage of the received signal energy – exotic CCD applications include deep space imaging, on-board missile guidance systems and see-in-the-dark military headsets.

Digital cameras using CCD are however now well under $1000 and offer performance which would be inconceivable 2 to 5 years ago.

The latest Sony Cybershot products for example, deliver 1.6, 2.1 or 3.3 Megapixel images, using 12 bit A/D conversion (to provide wide dark to light dynamic range), choice of a 4:3 or 3:2 aspect ratio image, digital zoom, in-camera resizing of stored images and MP4 movie mode – up to 60 seconds of moving images and sound which can either be stored (in a 'memory stick' module) or delivered (by e-mail).

HP's equivalent product (Photosmart) giving 2.24 Megapixel resolution, 32 bit colour depth and the option of 45 seconds of sound to be stored or sent with each photograph.

Which brings us to the tricky topic of image bandwidth. Our Hot Topic on displays pointed out that pixels are made of PELS – singular red, green or blue values of an RGB pixel – the number of bits per pixel determines the amount of colour balance control – 24 bits for example gives 'high colour depth'.

The bit rate/bandwidth requirement of an image is the number of pixels per second times the pixel address bandwidth.

The HP Photosmart example gives us a 2.24 Megapixel resolution with 32 bit colour depth. Wireless connectivity is provided by a 4 Mbit/second infrared connector or IEEE 1394 cable connector (delivering 100 to 200 Mbits/second). Even with in-camera re-sizing, these are large images. Note most importantly, how image bandwidth will almost certainly continue to increase over time effectively disenfranchising low bandwidth RF local access connectivity – Bluetooth and parallel RF local access options will need to deliver against a fast moving access performance benchmark driven by ever-increasing image bandwidth requirements.

CMOS image sensors typically use photodiodes to turn photons into electrons, digitise these values (including filtered colour intensity values) and post process the result. CMOS image sensors to date have been typically 100,000 pixel resolution (as opposed to CCD Megapixel resolution) but are lower cost and use less power (in addition to only needing a single supply voltage) when compared to CCD devices.

Each diode has a separate CMOS amplifier (hence 'CMOS' image sensor) with either off-chip or on-chip circuitry to reduce fixed pattern noise and perform colour balancing – the amplifiers are known as pixel gain amplifiers – PGA's and/or programmable gain amplifiers, the programmable function usually allows frame to frame fine tuning of resolution, frame rate and bit width and allows for flexible zooming, panning, filtering, flipping and mirroring (useful for security and surveillance).

Frame rate can be traded off against resolution and colour depth (number of bits used per pixel output).

Example	**Frame Rates (F/sec) at 10 bits vs 8 bits per pixel output**	
	10 bit (@ 16 MHz)	**8 bit (@ 32 MHz)**
1280 x 1024	9.3	18.6
1024 x 768	12.4	24.8

800 x 600	15.9	31.8
640 x 480	19.6	39.2
320 x 240	39.2	78.4

Table 1

As resolution increases (a function of decreasing geometry), the DSP post processing power budget increases typically to several hundred milliwatts, the dollar cost advantage over CCD should however continue to increase over time.

Dollar cost will also be driven by the substantial vendor competition in CMOS image sensors including Japanese vendors (eg Toshiba), US vendors (Conexant and TI) and European vendors (Philips with their 3.3 Volt See MOS solution).

Having captured the image (either still image or video stream) you may need to improve it (using QuickTime or equivalent) and then send it to your family and friends – next generation Internet being driven by egocentric edge inwards value.

You can, for example, send your photosnaps to photonet (www.photonet.com) owned by Kodak or to www.gatherround.com (owned by Intel) or to www.cartogra.com (owned by HP) or to www.photopoint.com (your picture on a Teacup) or to my-wedding, my-kids or my-party.com, or to ezprints.com, clulbphoto.com or zing.com. Your children can set up their own web site (using www.moonfruit.com) and post their own pictures.

As a result, our expectation of resolution and colour density and colour image quality will rapidly increase over time, driving image and video bandwidth requirements at the edge of the network (both delivery **and** memory bandwidth requirements – note how the HP PhotoSmart **starts** with 16 Mb of Flash memory).

This in turn is driving cable connection bandwidths (IEEE 1394) in terms of bit rate and bit error rate (effectively errorless channels).

Infrared is evolving in parallel to deliver multi-megabit local access at low error rates. RF local connectivity platforms will have to deliver against this fast moving access performance benchmark.

In terms of wide area access, the developments in image capture will drive the need for high quality (low bit error), low latency (effectively jitter free), high bit rate variable bit rate channel bandwidths – the performance benchmark against which IMT2000 DS and IMT2000 MC will need to be measured over time.

CCD AND CMOS IMAGE SENSORS

Both CCD and CMOS image sensors are devices for turning photons in to electrons – the varying voltage induced by the electron flow describes the light intensity focussed at each sensor point – the varying voltage is digitized to simplify post processing and image transfer.

CCD uses charge capture wells. The electrons are captured in a well. When the image is ready (after a pre-determined sampling period), the image is read out in a destructive way, ie when it is sent, the original information is lost.

The high resolution, low noise and black pixel performance (ability to discriminate between black and white pixels) make CCD particularly useful for high quality imaging including deep space imaging and deep space photometry (looking for faint stars). www.starlight-xpress.co.uk covers a number of CCD based deep space imaging applications.

In CMOS image sensors (complementary Metal Oxide on Silicon), the device for capturing photons and turning them into electrons is (usually) a photo diode. Each diode has a separate CMOS amplifier, intensity values are read as outputs from all the individual amplifiers. Noise performance and resolution is not as good as CCD but costs and power consumption are usually lower.

On Line Archiving/Photo Presentation

www.photonet.com (Kodak)

www.gatherround.com (Intel)

www.cartogra.com (HP)

www.photopoint.com (teacups, clocks)

www.ofoto.com (Jim Barksdale – ex Netscape)

www.shutterfly.com (Jim Clark – ex Netscape)

www.my-wedding.com

www.my-kids.com

www.my-pets.com

www.my-party.com

www.ezprints.com

www.clubphoto.com

www.zing.com

www.photonut.com Digital camera web site.

CMOS Imaging Products and Associations

www.pixelcam.com

www.symagery.com

www.sony.jp

www.conexant.com

www.toshiba.com

www.philips.com (Philips 3.3 volt See MOS)

www.cadence.com (Bayer 2G image quality enhancement)

www.analog.com

www.oida.org (Optical Electronics Industry Development Association).

www.apple/com/quicktime/specification.html (16 Mb RAM)

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