Visual Imaging and the Electronic Age

Display Technology

Lecture #12
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Liquid Gold

The Story of Liquid Crystal Displays and the Creation of an Industry

Joseph A. Castellano
A Pixel Consists of Approximately 2 2/3 Triads
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Liquid Crystal Color Displays
Different Pixel Configurations

TV CRT
PC CRT
XO-1 LCD
LCD
Important Properties of Liquid Crystals

- Crystals are transparent
- Can alter the orientation of polarized light passing through them
- Polarization properties can be changed by applying electrical field
- Switching can be done fast
Polarization of Liquid Crystal

Polarizer

Glass

E=0

Lights

On

Off
Liquid Crystal Color Display
Snake River

The Tetons, Ansel Adams 1942
LCD Advantages & Disadvantages

• Can have high resolution. (Corning & Samsung)
• Requires very flat glass panels which are now being produced relatively cheaply.
Plasma Display Technology
Plasmaco 60” Diagonal HDTV Plasma Display Panel
Plasma Display: Advantages & Disadvantages

• The advantage is that they can have high brightness (at the expense of watts). Thus can be used in brightly lit areas.

• The difficulty with plasma displays is that the cell size (pixel) is large relative to a liquid crystal. Thus for a given resolution, the screens must be large.
Digital Micromirror Devices (DMD)

- Pioneered by Texas Instruments. The research on these micromechanical (MEMs) devices started in 1977.
- The first digital light valve projection systems (DLPs) had mirrors measuring 17 microns per side. At 1280 x 1028 resolution (HDTV) this resulted in a rather large chip in 1996.
- Today this technology is used in almost all digital theaters and some home televisions.
- Most theaters now use DLP with 4K resolution (4096 x 2160)
DMD Structure

Digital Micromirror Device (DMD™)
A True Microelectromechanical System
DMD™ Grayscale Projection
Pulsewidth Modulation

Reset and Parallel Update

Word

MSB (1000)

(0100)

(0010)

LSB (0001)

Number of LSB Times

8

4

2

1

Field Time = 1 + 2 + 4 + 8 = 15 LSB Times

(4-Bit, 16 Gray-Level Example)
How Grayscale is Created

DMD™ Binary Pulsewidth Modulation

Input

(1111)
(1001)
(0100)
(0010)
(0001)
(0000)

Video Field Time

(Sensations of Gray Shade®
By Viewer’s Eye)

4-Bit, 16 Gray-Level Example
Example: Lenna Original
3-Chip DLP Optical System

- Condenser Lens
- Lamp & Reflector
- DMD3 (B)
- TIR Prism
- Projection Lens
- DMD2 (G)
- Color-Splitting/Color-Combining Prisms
- DMD1 (R)
DLP Projection System

Compact Imaging Assembly
Christie CP4230 Digital Cinema Projector

- 4K DLP
- Screen size up to 105ft (32m)
- 4096 x 2160 resolution
- 2100:1 contrast
Cost of HDTV Displays

- LCD’s
- Plasma
- Projection TV’s

Price $ vs. Diagonal Inches
Cost of HDTV Displays

Note: Each year the cross over points keep moving to the right.
Modifications to Existing Technology

• The quest for size
• The quest for brightness
• The quest for energy reduction
Cornell Panoramic Projection System
NASA Ames Control Room

FutureFlight Center at NASA-Ames
Stonybrook’s Reality Deck
Stony Brook’s Reality Deck (video)

http://www.youtube.com/watch?v=OpsrFjZ8WJk
Samsung 110-inch 4K UHD TV 2014
Visual Adaptation

- starlight: -6
- moonlight: -4
- indoor lighting: -2
- sunlight: 0
- displays: 2
- 4
- 6
- 8

- scotopic
- mesopic
- photopic

- poor contrast
- no color
- low acuity
- good contrast
- good color
- high acuity
Sunnybrook Display Technology

High resolution colour LCD

High Dynamic Range Display

Low resolution Individually Modulated LED array
Sunnybrook Display Technology

HDR Image  LED array  LCD with correction  Output image
How E-Paper Works
How E-Paper Works

GYRICON BEADS

LIGHT STATE

DARK STATE

ELECTRODE

E INK MICROCAPSULES

LIGHT STATE

DARK STATE

NEGATIVELY CHARGED

POSTIVELY CHARGED

Electronic ink is a straightforward fusion of chemistry, physics and electronics to create this new material.
Flexible Tablet-Sized Display From L.G. Philips LCD and E Ink Corporation
She turned and gestured in the direction of the six-dime counter. There, on one of the stools, sat Cappin’s owner, drinking a cup of coffee and reading the Smokey.

Cappin’s grandfather invited the man to join them. When they were seated, he asked Billy if the pups were indeed his.

“Some of them,” Billy said. “Cappin got old out in a fox. I’ve got to find a place for half the litter. But what I really think I’ll do is keep ’em, and Cap done on ’em, and I’ve only had one dog. He gets lonely.”

Edgar’s grandfather explained about his own litter, and about Vi, expanding on her qualities, and then he offered to trade a pup for a pup. He told Billy he could have the pick of Vi’s litter, and furthermore...
Polymer Vision's Readius with rollable display

http://crave.cnet.co.uk/gadgets/0,39029552,49287756-1,00.htm
End