Digital Video Basics

presentation at VSF 2010

Digital Video Basics

- In the Digital Era, all data is recorded, stored, and transmitted in digital form
  - Including pictures and sound
- A digital picture is composed of a 2D array (W x H) of “pixels” (picture elements)
- Each pixel is a block represented by a binary number indicating its color
  - “True Color” = 24 bits = 3 8-bit channels (RGB)
    - 8 bits = 256 shades per channel
    - 256 x 256 x 256 = 16,777,216 mixed colors
  - More than human eye can distinguish
    - Humans perceive 1-10M colors

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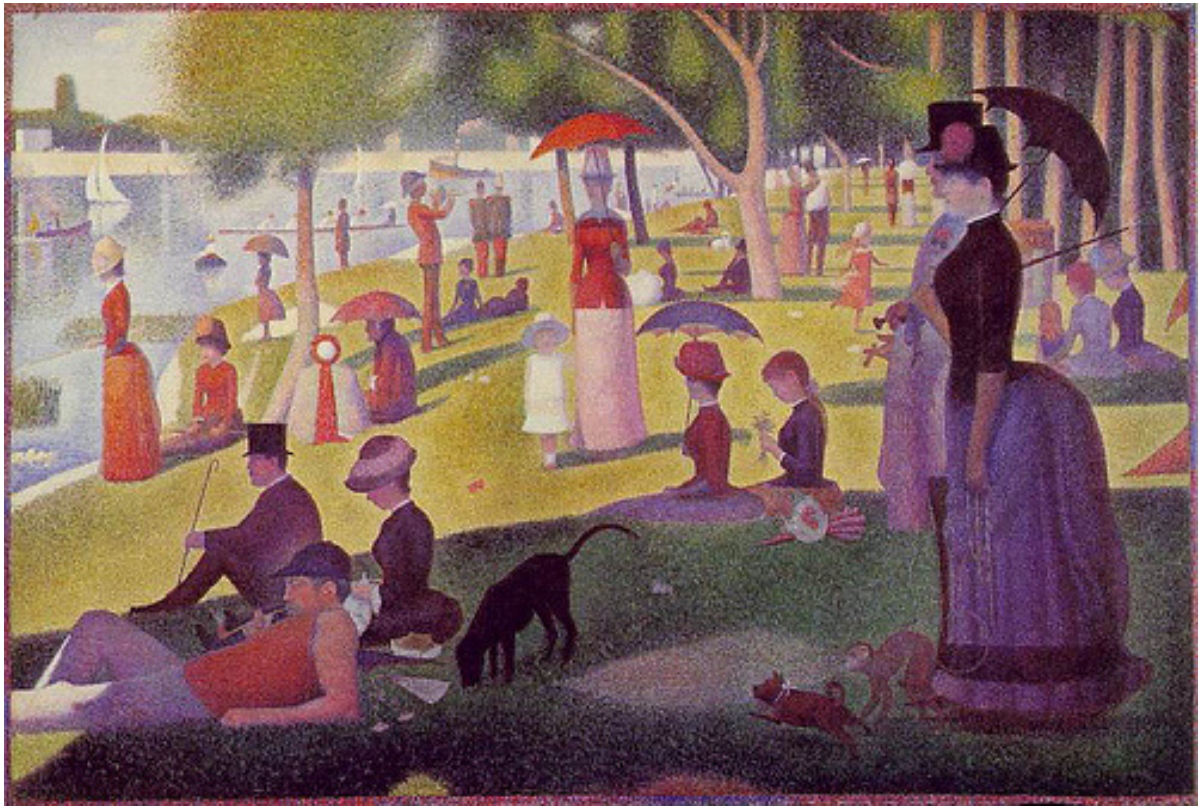
Pixel Pictures Not New Idea



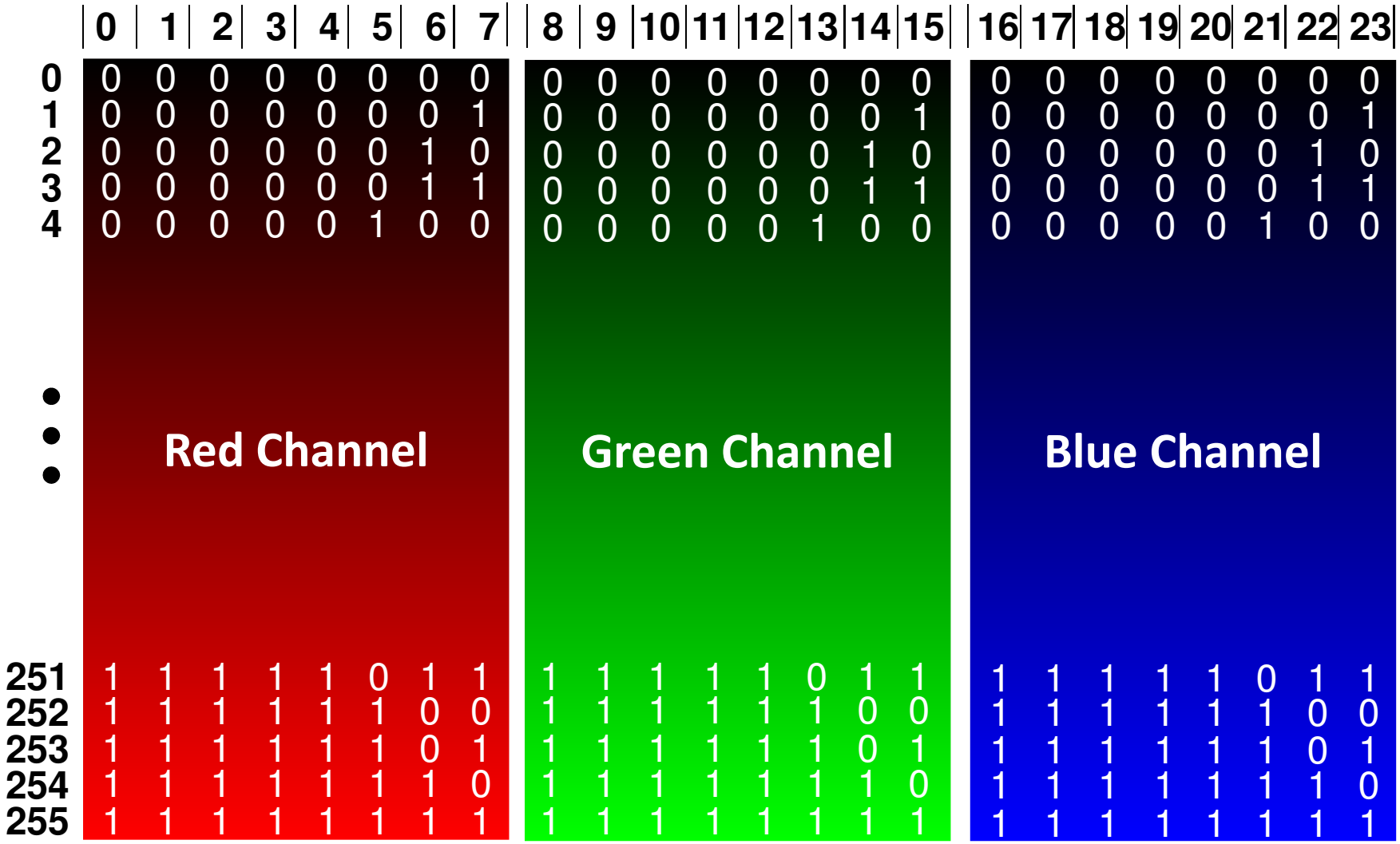
Detail

Le Grand Jatte (aka "Sunday in the Park")

George Seurat – 120 x 81 (inches)

Estimated to contain 3,456,000 dots (started in 1884, finished in 1886)

24-Bit “True Color” Scheme



Pixel Number (W x H)

- **Fixed by standard/device**
  - **Mobile: 128 x 96 (sub-quarter CIF)**
  - **Videoconferencing: 352 x 288 (CIF) (Common Intermediate Format)**
  - **SDTV: 640 x 480 (NTSC) or 720 x 576 (PAL)**
  - **HDTV: 1280 x 720p or 1920 x 1080i**
  - **WQXGA: 2560 x 1600**
    - **Wide Quad eXtended Graphics Array**
  - **Digital Cinema Initiatives (DCI): 24fps**
    - **2K = 2048 x 1080 (also use similar 1920 x 1080 HD format at p24 frame rate)**
    - **4K = 4096 x 2160**

Video: Frames Per Second

- Depends on application
  - Time lapse: 1 frame/minute to 1 frame/year
  - Surveillance: 10 or less
  - Mobile: 15-20
  - Film: 24
  - SDTV: 25 (PAL) or 30 (NTSC)
  - HDTV: 25/30 (1920 x 1080) or 50/60 (1280 x 760)
  - High speed: 100 to 200M per second
    - 100 frames = 3.33 seconds to playout at 30 fps
    - 1000 frames = 33.3 seconds to playout at 30 fps
    - 200M frames >77 days to playout at 30 fps

Key Pixel Facts

- Doubling resolution quadruples pixels (2 x 2)
- Aspect ratios rectangular (W>H) due to HVS
  - 1.33:1 (classic 4:3 – 33% wider than high)
  - 1.60:1 to 1.85:1 (widescreen formats, e.g. 16:9)
  - 2.35:1 (cinemascope, panavision, superscope)
- Density (pixels per inch or ppi) not constant
  - Varies by size for fixed formats (e.g., 1920 x 1080)
  - Useful density depends on viewing distance
    - 300 ppi = photo-quality prints (close up)
    - 72-100 ppi = typical monitors, displays (2-3 feet)
    - 48 ppi = 19” SDTV or 50” HDTV (7-10 feet)

The Problem with Digital Video

- The bits add up to staggering numbers:
  - 1 SD frame = 345,600 pixels x 24 bits/pixel = 8,294,400bpf
  - 1 second video = 30fps x 8,294,400bpf = 248,832,000bps
  - HD can be as much as 6X more = 1,492,992,000bps
- Can't store or transmit 250Mb/sec of data for SD, let alone 1.5Gb/sec for HD
- Fortunately, in video, most of the bits are either redundant or uninteresting

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