CSE4203: Computer Graphics

Chapter – 3

Raster Images

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Outline

- Raster and Raster Images
- Display Devices
- Pixel Values
- RGB Color
- Alpha Compositing

Raster (1/1)

- Most computer graphics images are presented on *raster display.*
  - i.e. television
  - has rectangular array of small light-emitting pixels
    - individually set to different colors to create desired image.

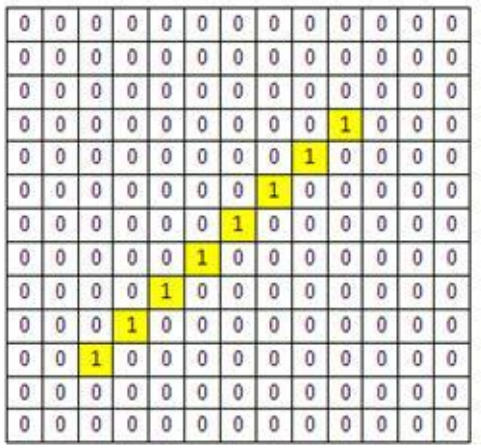
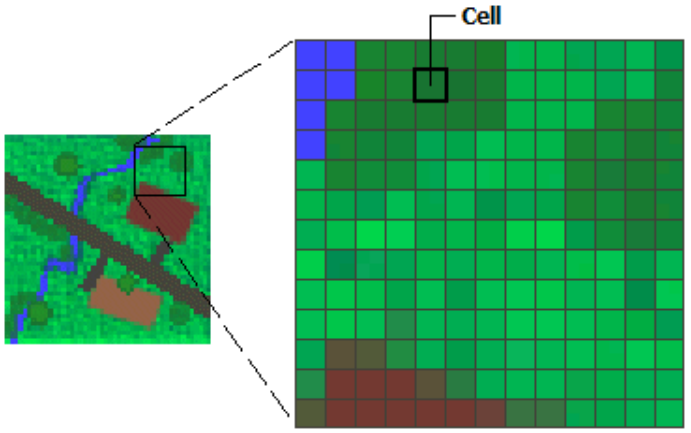


Image Source: Internet

Storing Images (1/2)

- Raster Image:
  - used to store and process images, as rasters are common in devices

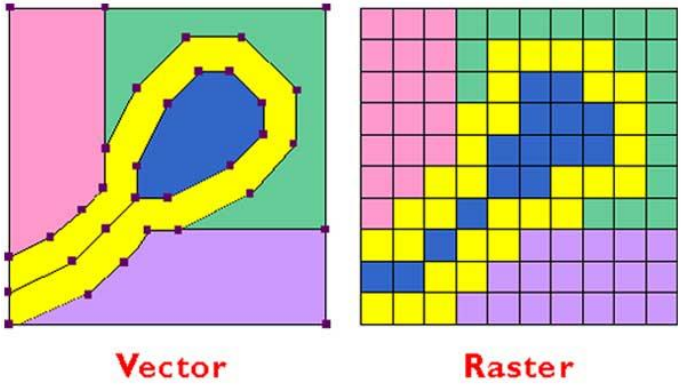


- simply a **2D array**
- stores the pixel value for each pixel
- usually a color stored as **three numbers (r, g, b)**

Image Source: Internet

Storing Images (2/2)

- Vector Image:
  - storing descriptions of shapes
  - areas of color bounded by lines or curves
  - no reference to any pixel grid.



- Need to store *instructions for displaying the image rather* than the pixels needed to display it.

  - **Q: Advantage/ Disadvantage?**

Image Source: Internet

Raster Devices (1/1)

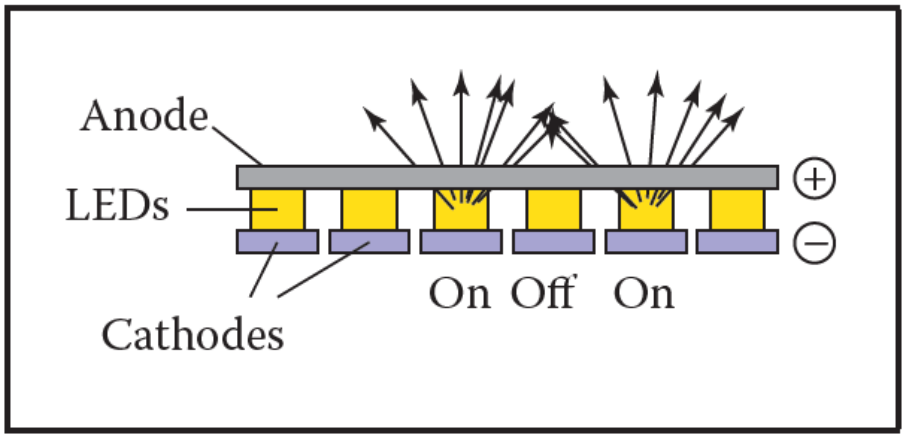
- **Output**
  - Display
    - Transmissive: liquid crystal display (LCD)
    - Emissive: light-emitting diode (LED) display
  - Hardcopy
    - Binary: ink-jet printer
    - Continuous tone: dye sublimation printer
- **Input**
  - 2D array sensor:
    - digital camera
  - 1D array sensor:
    - flatbed scanner

Display Devices (1/1)

- Transmissive Displays:
  - require a light source to illuminate them
  - backlight behind the array
    - i.e. in a projector, a lamp emits light projected onto the screen after passing through the array.
- Emissive Display:
  - it is its own light source.

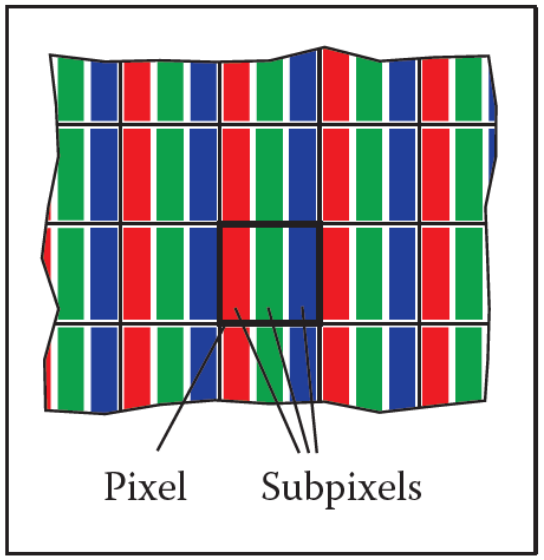
Emissive Displays (1/2)

- Emissive Displays:
  - Example: light-emitting diode (LED)
  - Each pixel is composed of one or more LEDs (semiconductor devices)
    - emit light with intensity ↔ electrical current passing through them



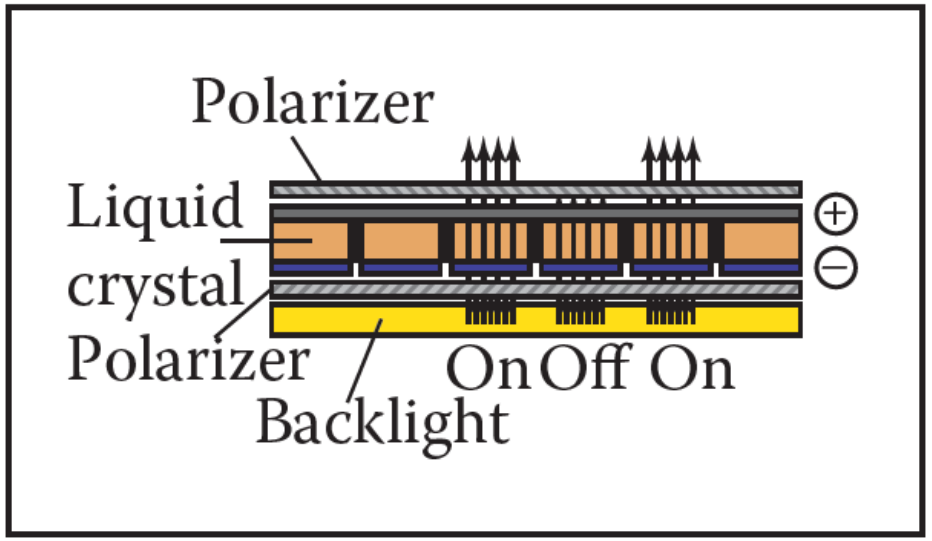
Emissive Displays (2/2)

- Sub-pixel:
  - Pixels divided into three independently controlled sub-pixels (R, G, B)
    - each with own LED (different materials)
    - emit light of different colors



Transmissive Displays (1/2)

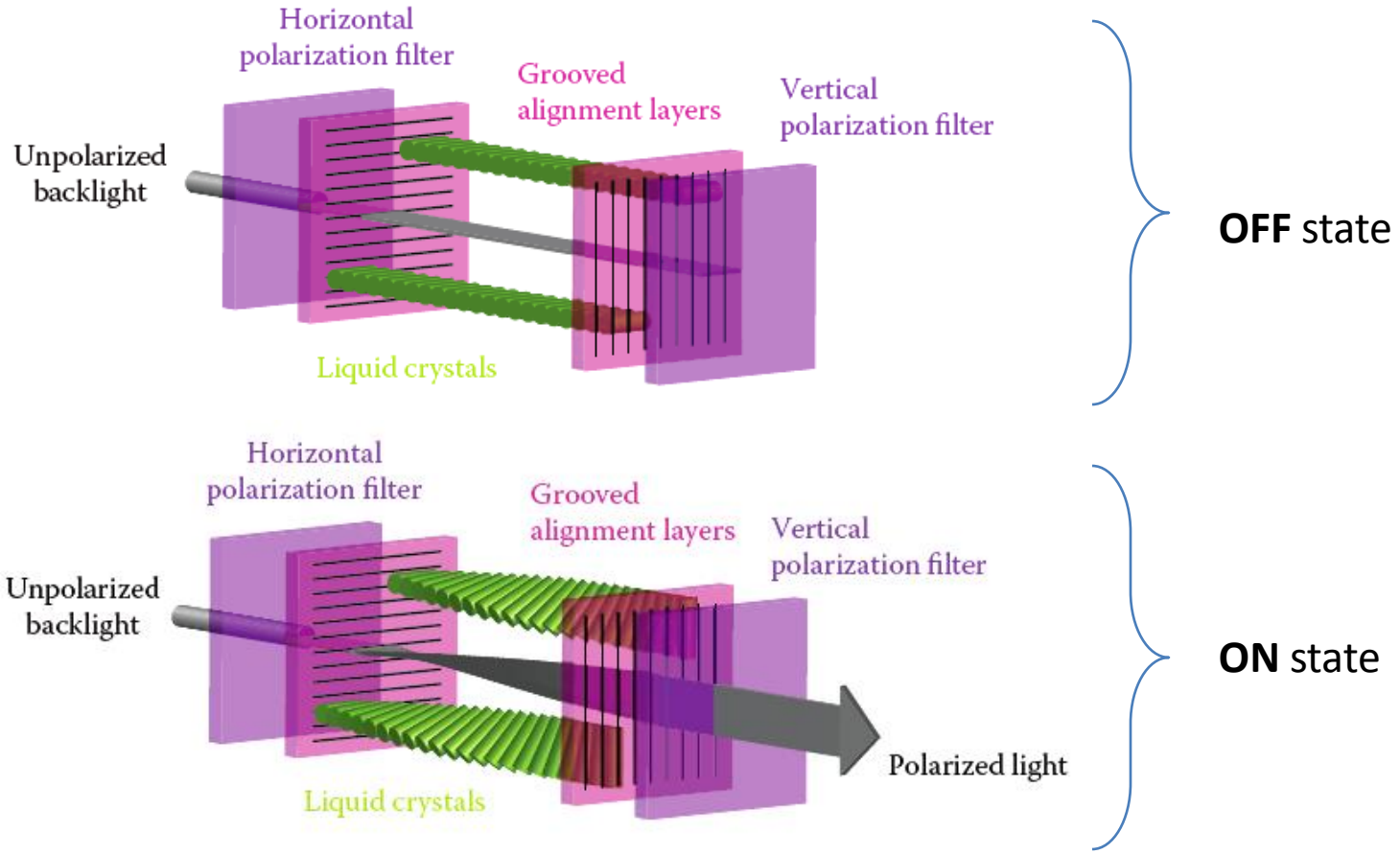
- Transmissive Displays:
  - Example: light crystal display (LCD)



  - Molecular structure of liquid crystal rotates the polarization of light that passes through it
  - LCDs also have sub-pixels.

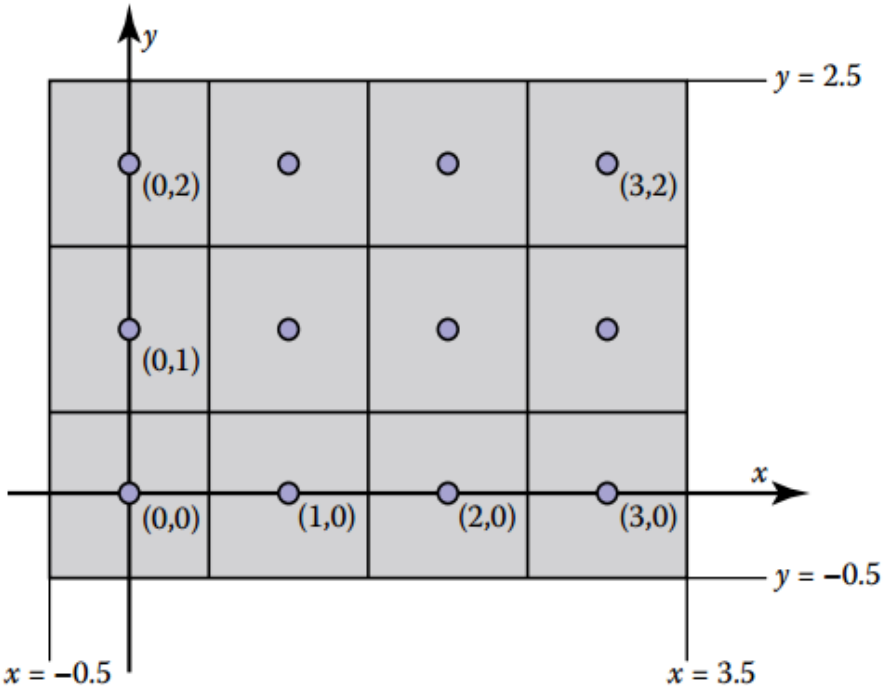
Transmissive Displays (2/2)

- Degree of rotation ↔ applied voltage



Pixel Values (1/3)

- Coordinate system for raster screen:
  - Convention:



Pixel Values (2/3)

- It is sufficient for pixels to have a bounded range, usually taken to be [0, 1] for simplicity.
  - i.e. possible values in an 8-bit image: {0, 1/255, 2/255,. . . , 254/255, 1}.

  - **high dynamic range (HDR):** stored with floating-point numbers, allowing a wide range of values.
  - **low dynamic range (LDR):** fixed-range images that are stored with integers.

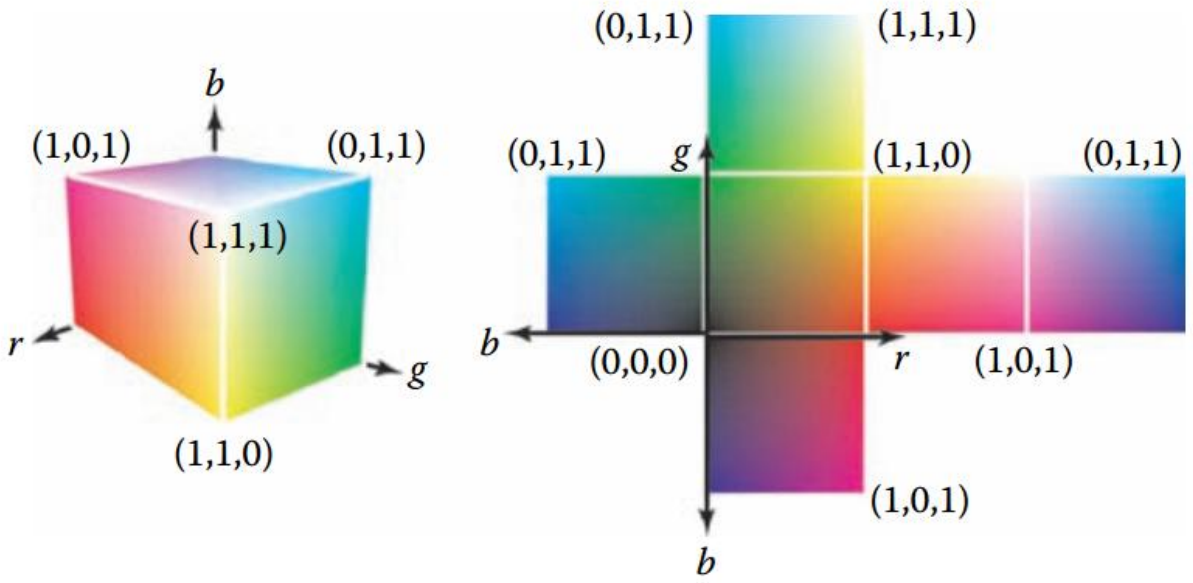
Pixel Values (3/3)

- Example

Image Source: Internet

RGB Color (1/1)

black = (0, 0, 0), red = (1, 0, 0), green = (0, 1, 0),
blue = (0, 0, 1), yellow = (1, 1, 0), magenta = (1, 0, 1),
cyan = (0, 1, 1), white = (1, 1, 1)



Alpha Compositing (1/5)

- Partially overwriting the contents of a pixel.
  - Where we have a background and want to insert a foreground image over it.
    - Transparent
    - Opaque (not transparent)
    - Partially Transparent

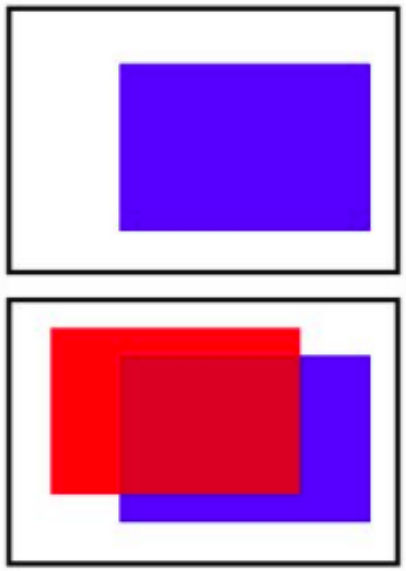


Image Source: Internet

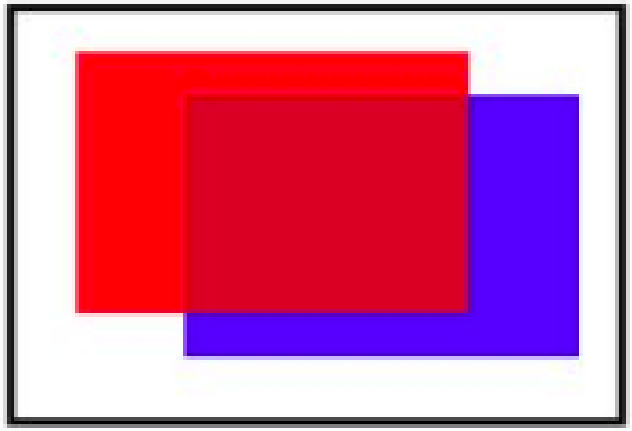
Alpha Compositing (2/5)

- Partially transparent:
  - when the foreground object only partly covers the pixel
    - Seen through glass
  - or when there are sub-pixel holes
    - between the leaves of a distant tree.

- foreground and background must be blended

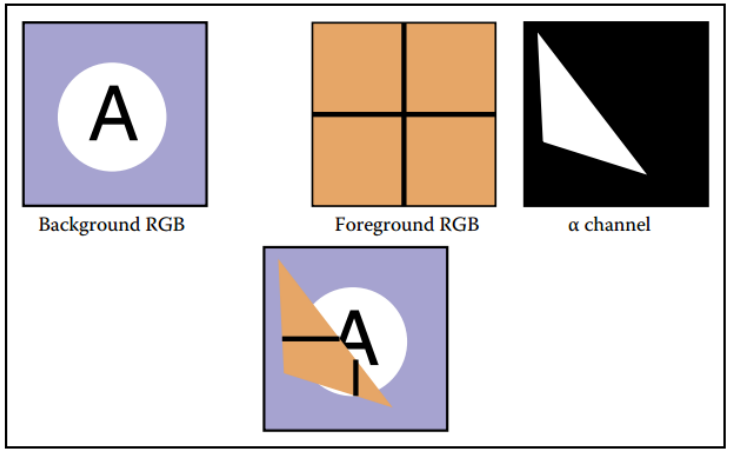
Alpha Compositing (3/5)

$$c = \alpha c_f + (1 - \alpha)\, c_b$$

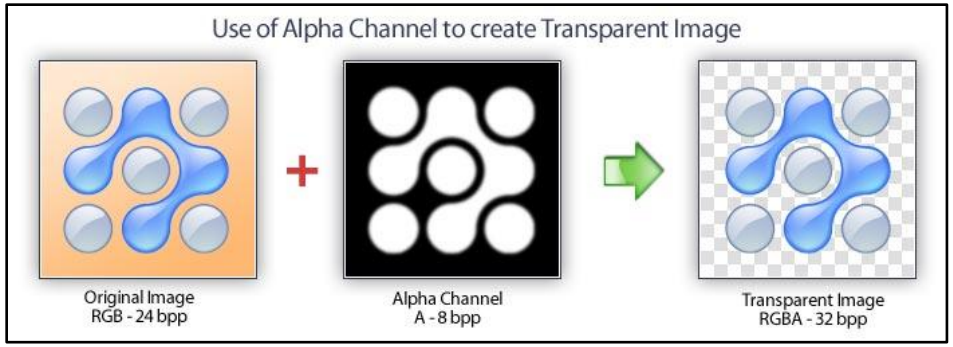


Alpha Compositing (4/5)

- Alpha Mask:
  - The α values for all the pixels is stored in a separate gray scale image.



Example - 1

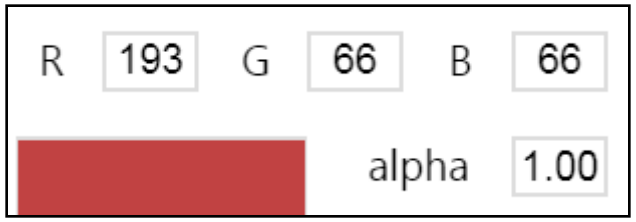


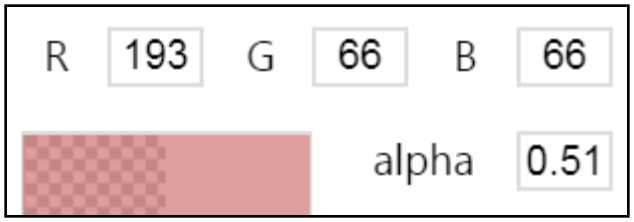
Example - 2

Image Source: Internet

Alpha Compositing (5/5)

- Alpha Channel:
  - The α values are stored as a fourth channel in an RGB image
    - i.e. RGBA





Additional Reading

- 3.1.2: Hardcopy Devices.
- 3.2.1: Pixel formats with typical applications.
- 3.2.2: Monitor Intensities and Gamma.
- Frequently Asked Questions

Thank You