

Raster Devices and Images

virtually all graphics system are raster based

scanner

linear array of pixels swept across page to create grid of pixels



printer

image is made by depositing ink at points on a grid

display

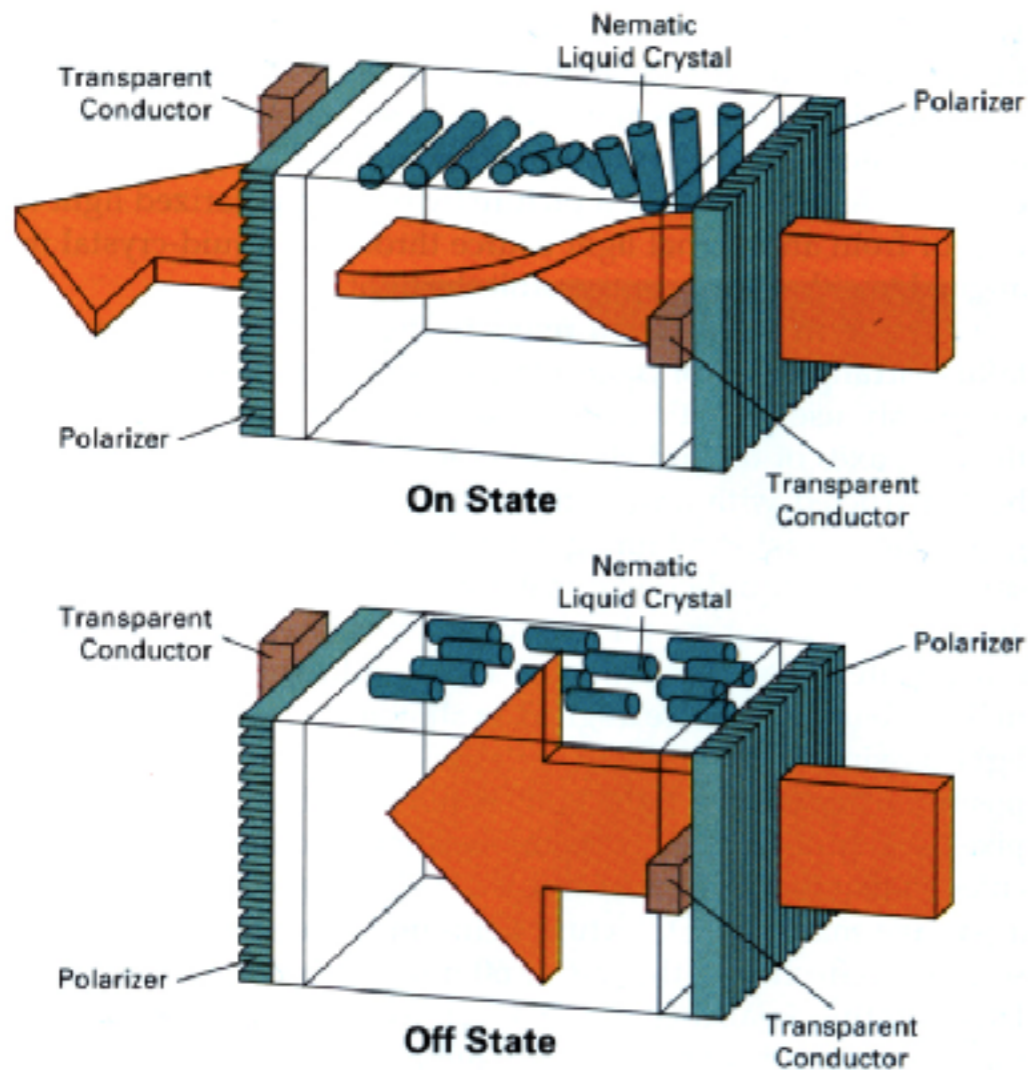
shows images as a rectangular array of pixels



digital camera

image sensors made of grid of light-sensitive pixels

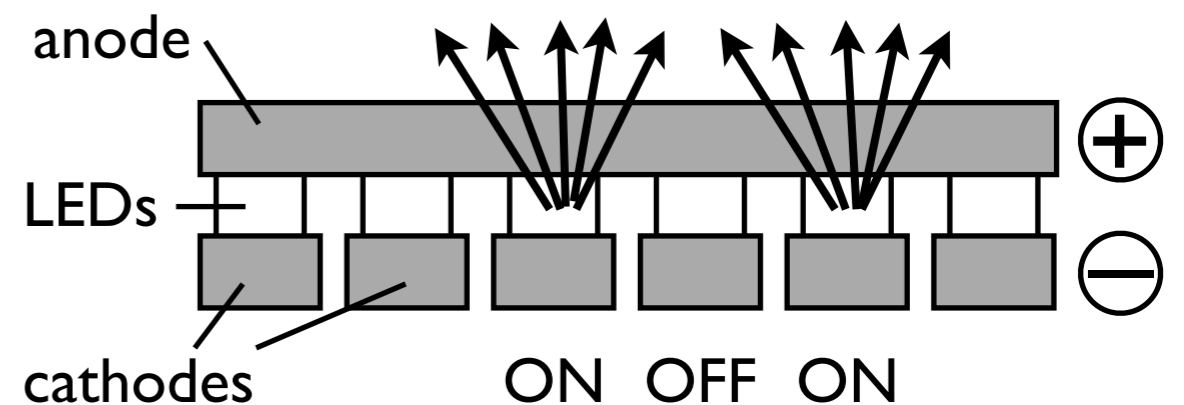
Displays are either transmissive or emissive



[H&B, Fig. 2-16]

one pixel of an **LCD** display

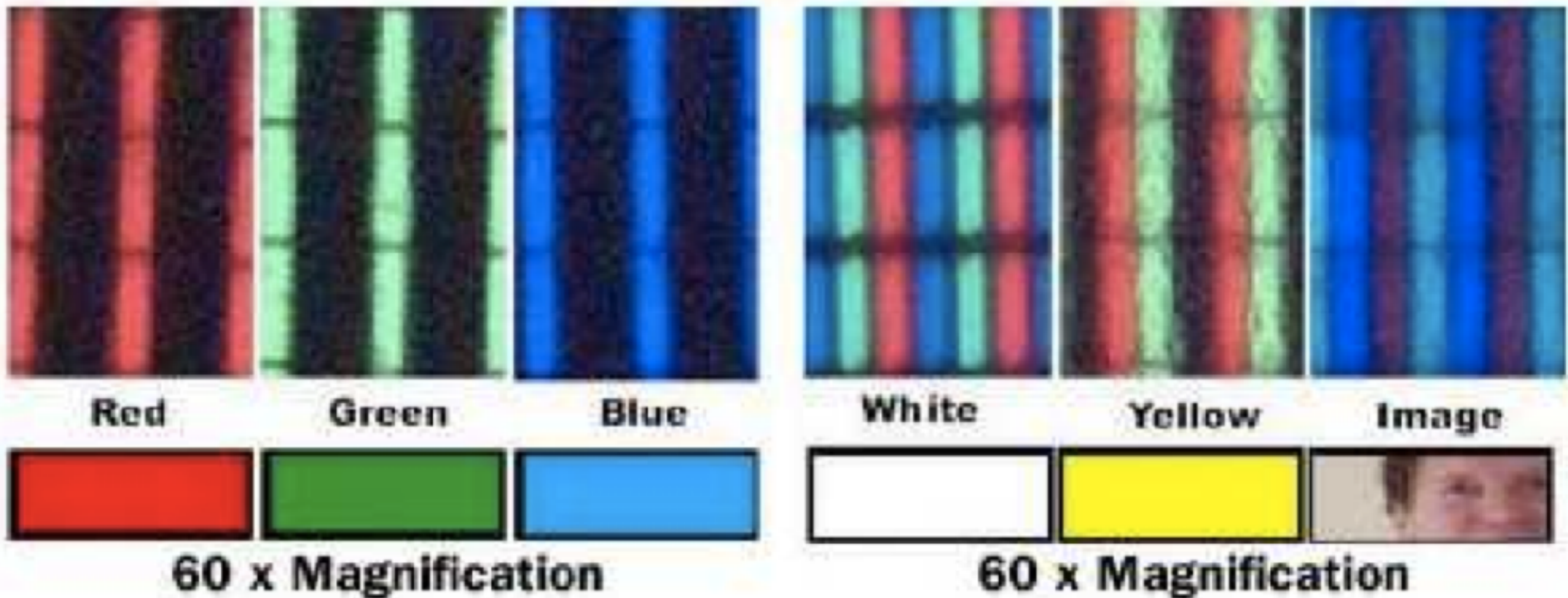
on state liquid crystal rotates the polarization of the light so it can pass through the front polarizer
off state front polarizer blocks light that passes the back polarizer



LED display

each pixel is composed of one or more **LEDs**, semiconductor devices that emit light with intensity dependent on current

Raster Display



get different colors by combining **red, green, and blue subpixels**

What is an image?

Continuous image

$$I : R \rightarrow V$$

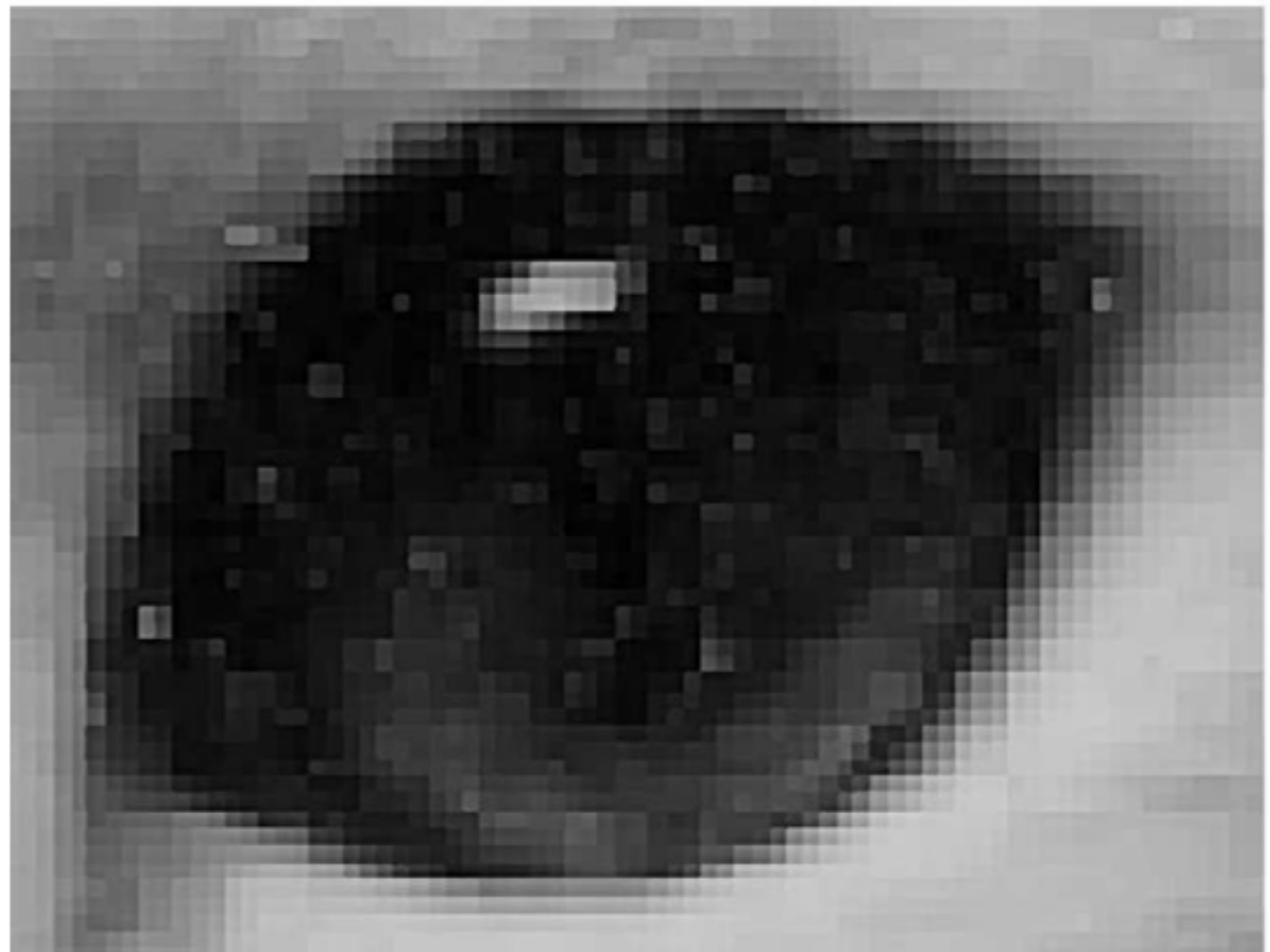
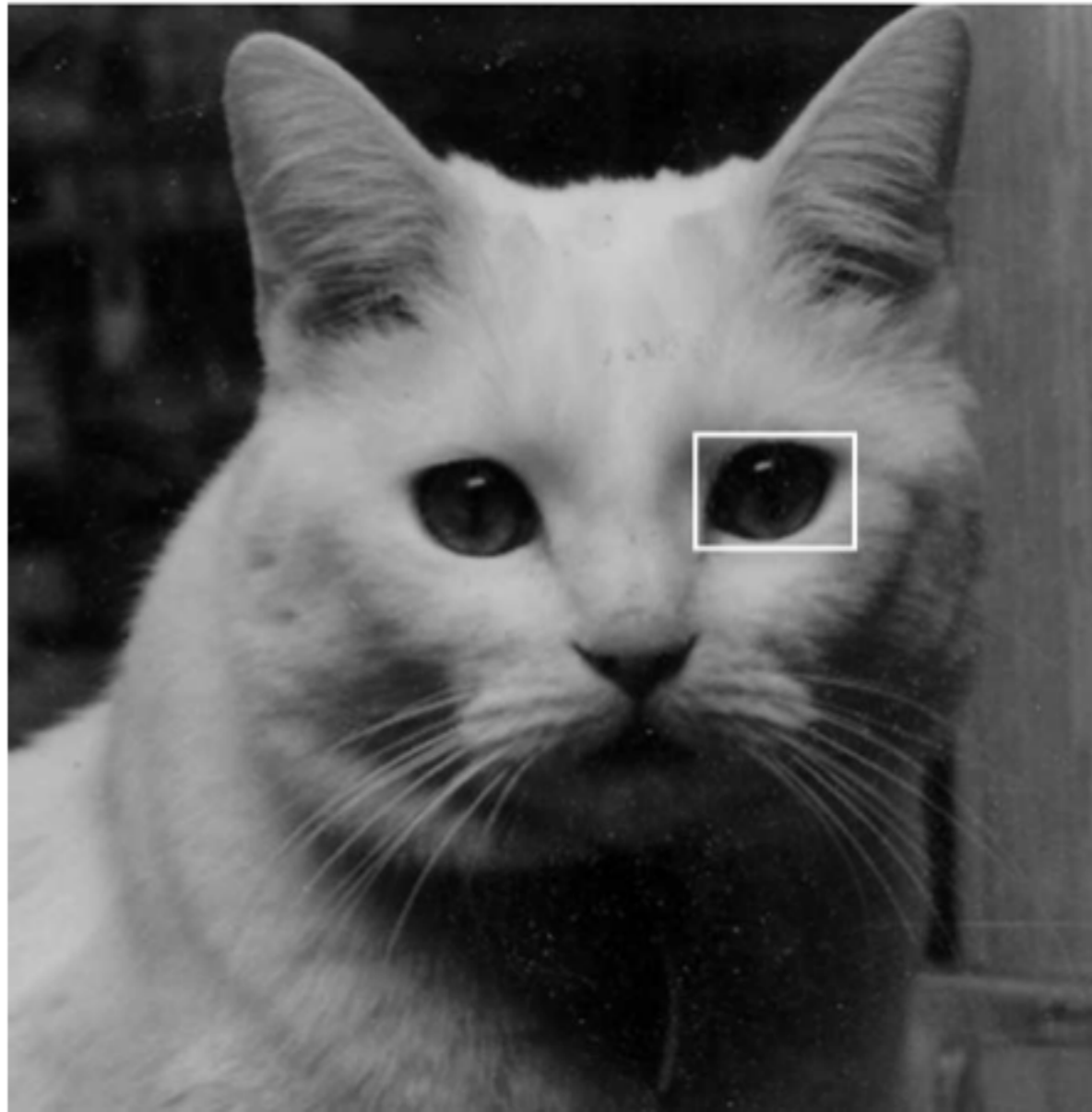
$$R \subset \mathbb{R}^2$$

$$V = \mathbb{R}^+ \quad (\text{grayscale})$$

$$V = (\mathbb{R}^+)^3 \quad (\text{color})$$



Raster Image



A **raster image** is 2D array storing pixel values at each pixel

What is an image?

Raster image

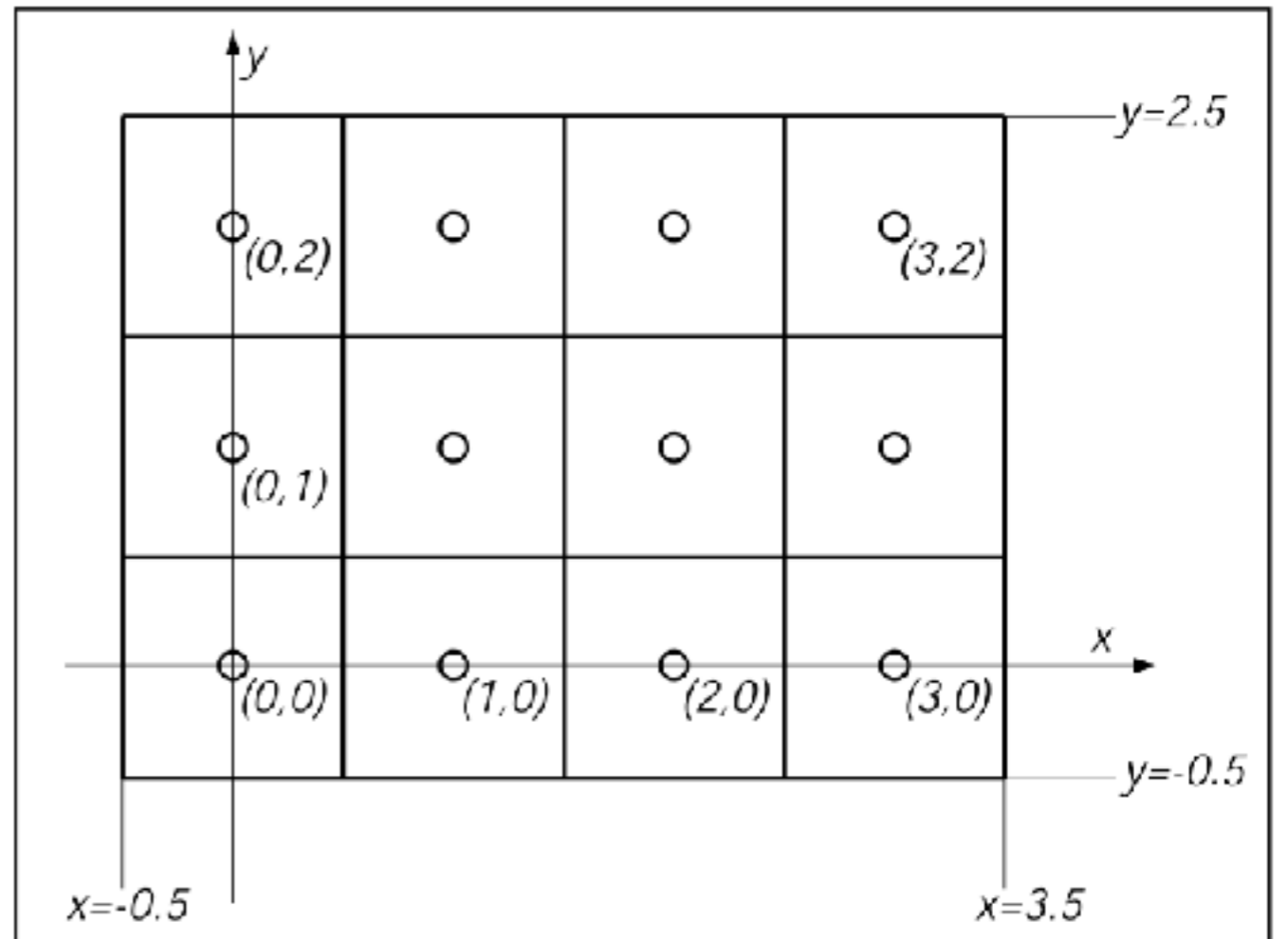
$$I : R \rightarrow V$$

$$R \subset \mathbb{Z}^2$$

$$V = \mathbb{R}^+ \quad (\text{grayscale})$$

$$V = (\mathbb{R}^+)^3 \quad (\text{color})$$

Each pixel value represents the **average color** of the image over that pixel's area.



$$[-0.5, n_x - 0.5] \times [-0.5, n_y - 0.5]$$

n_x = number of columns

n_y = number of rows

What is an image?

Raster image

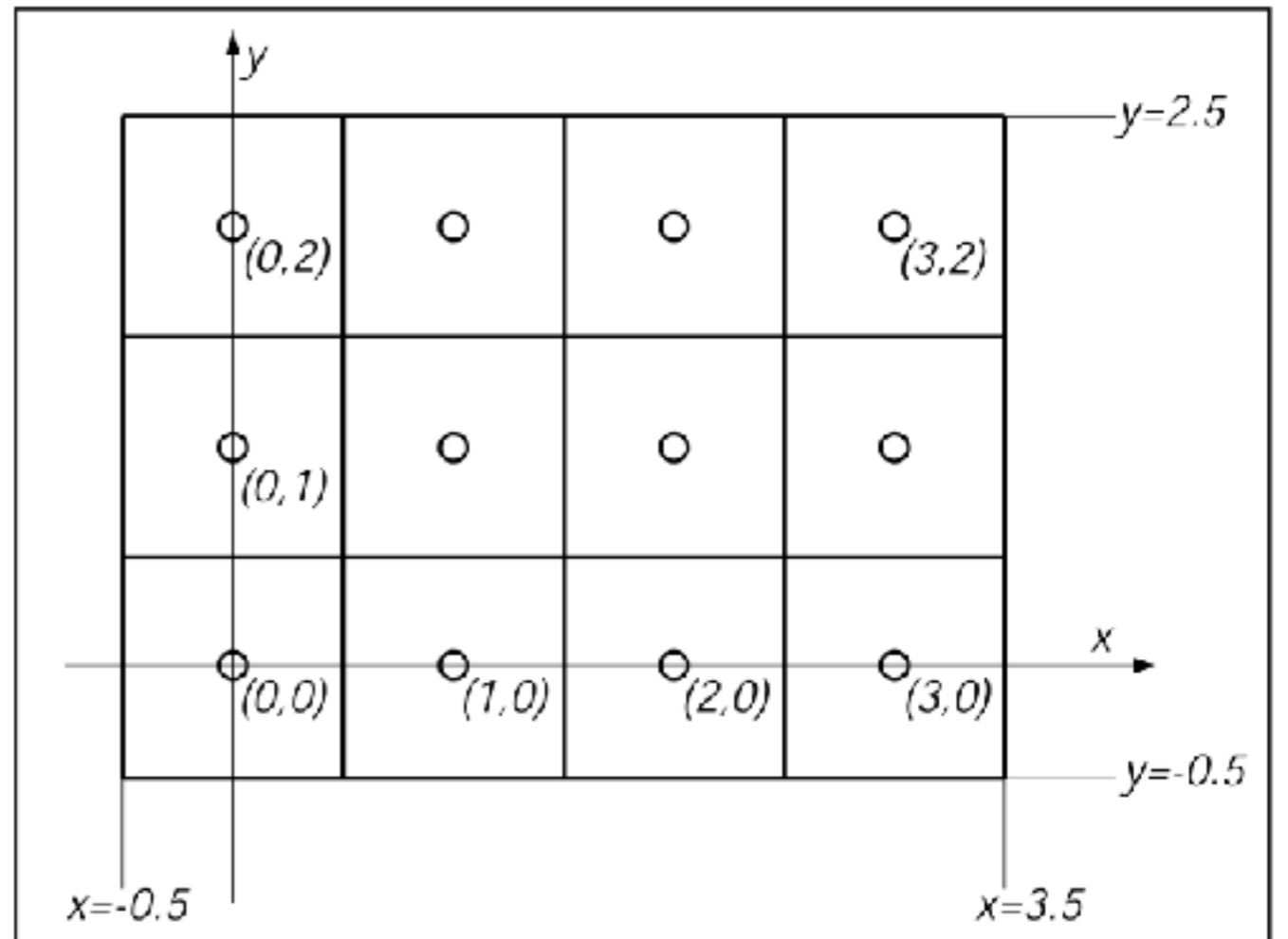
$$I : R \rightarrow V$$

$$R \subset \mathbb{Z}^2$$

$$V = [0, 1] \quad (\text{grayscale})$$

$$V = [0, 1]^3 \quad (\text{color})$$

Each pixel value represents the **average color** of the image over that pixel's area.



$$[-0.5, n_x - 0.5] \times [-0.5, n_y - 0.5]$$

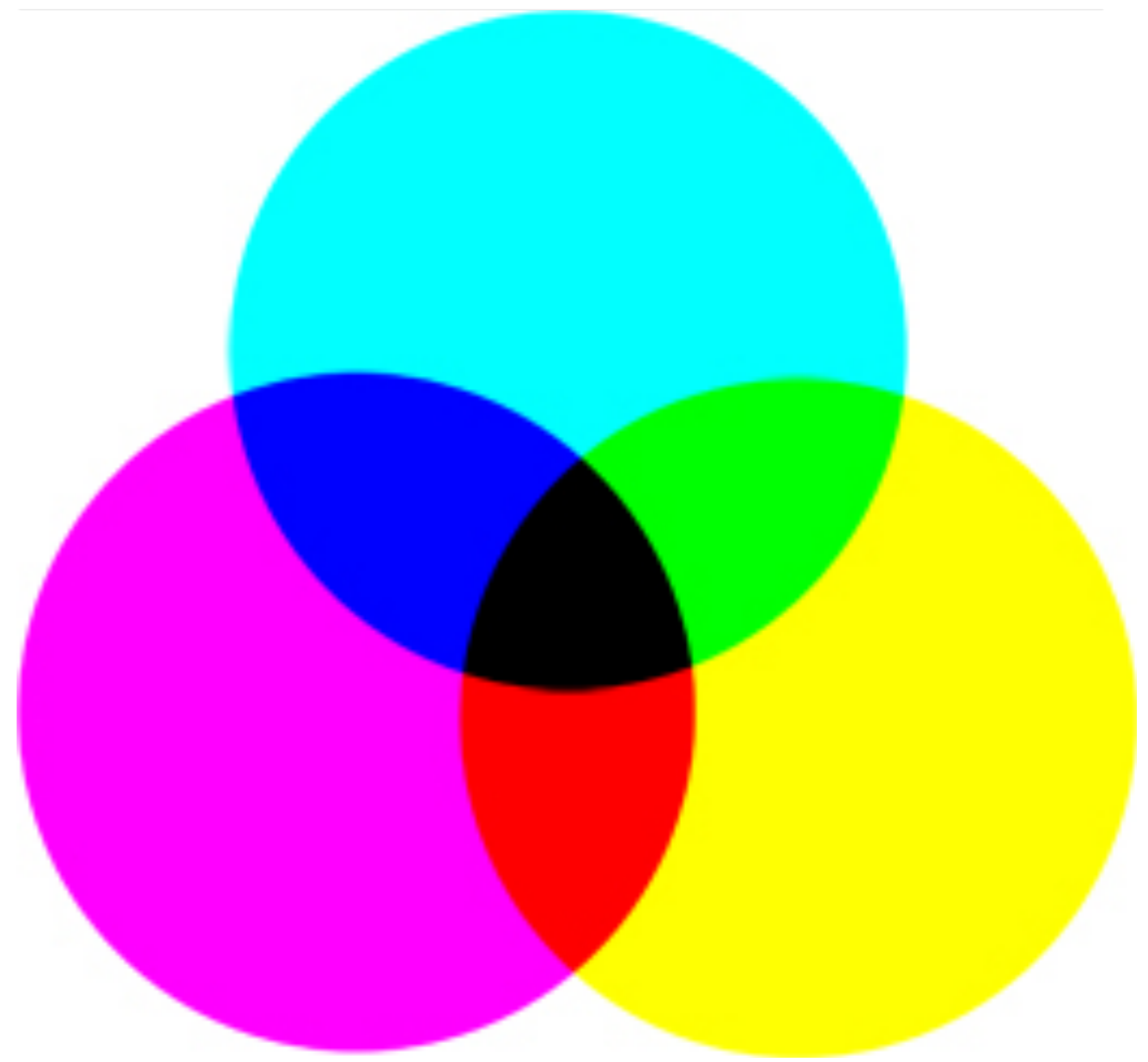
n_x = number of columns

n_y = number of rows

Color Representation

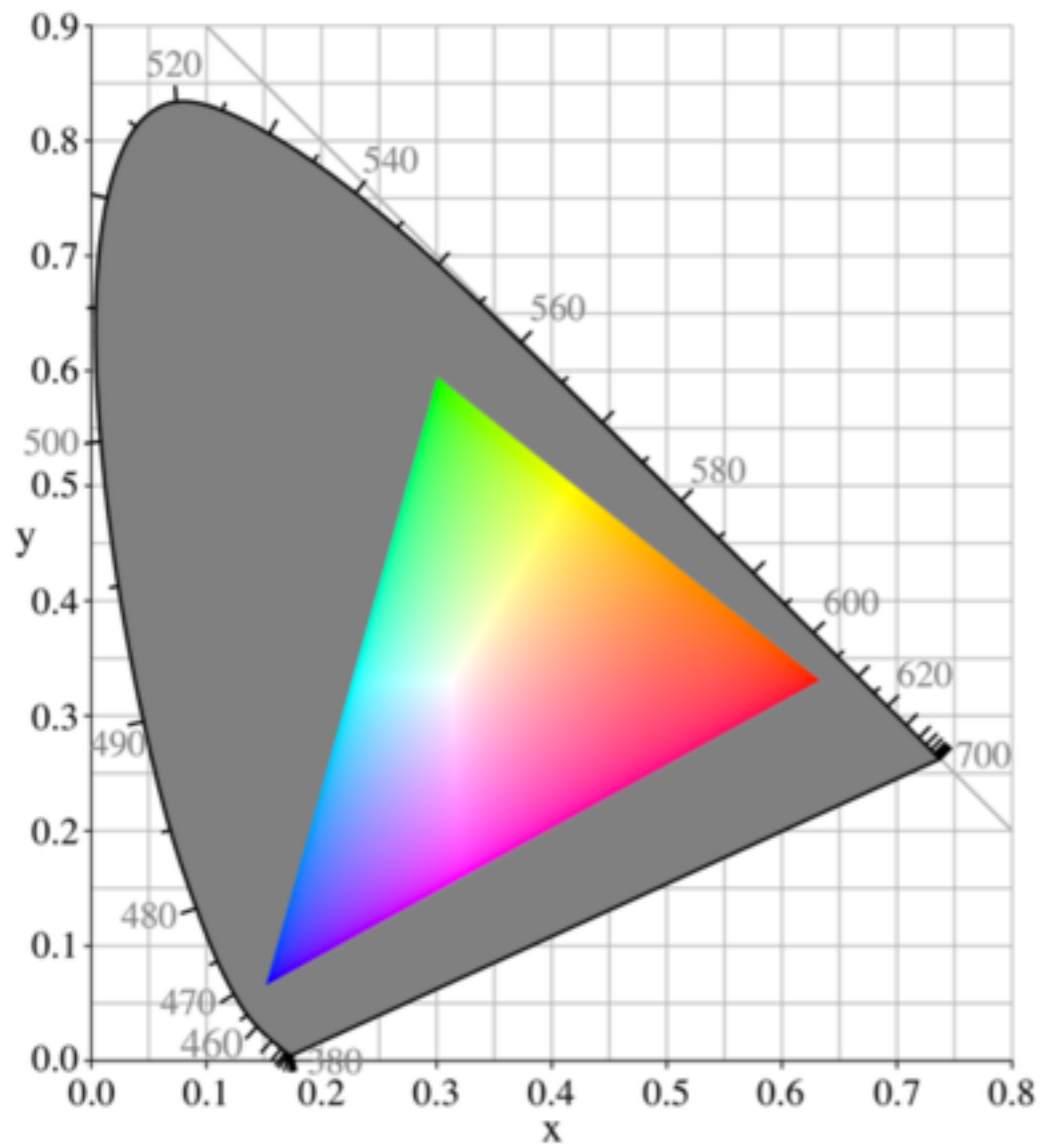


additive
RGB

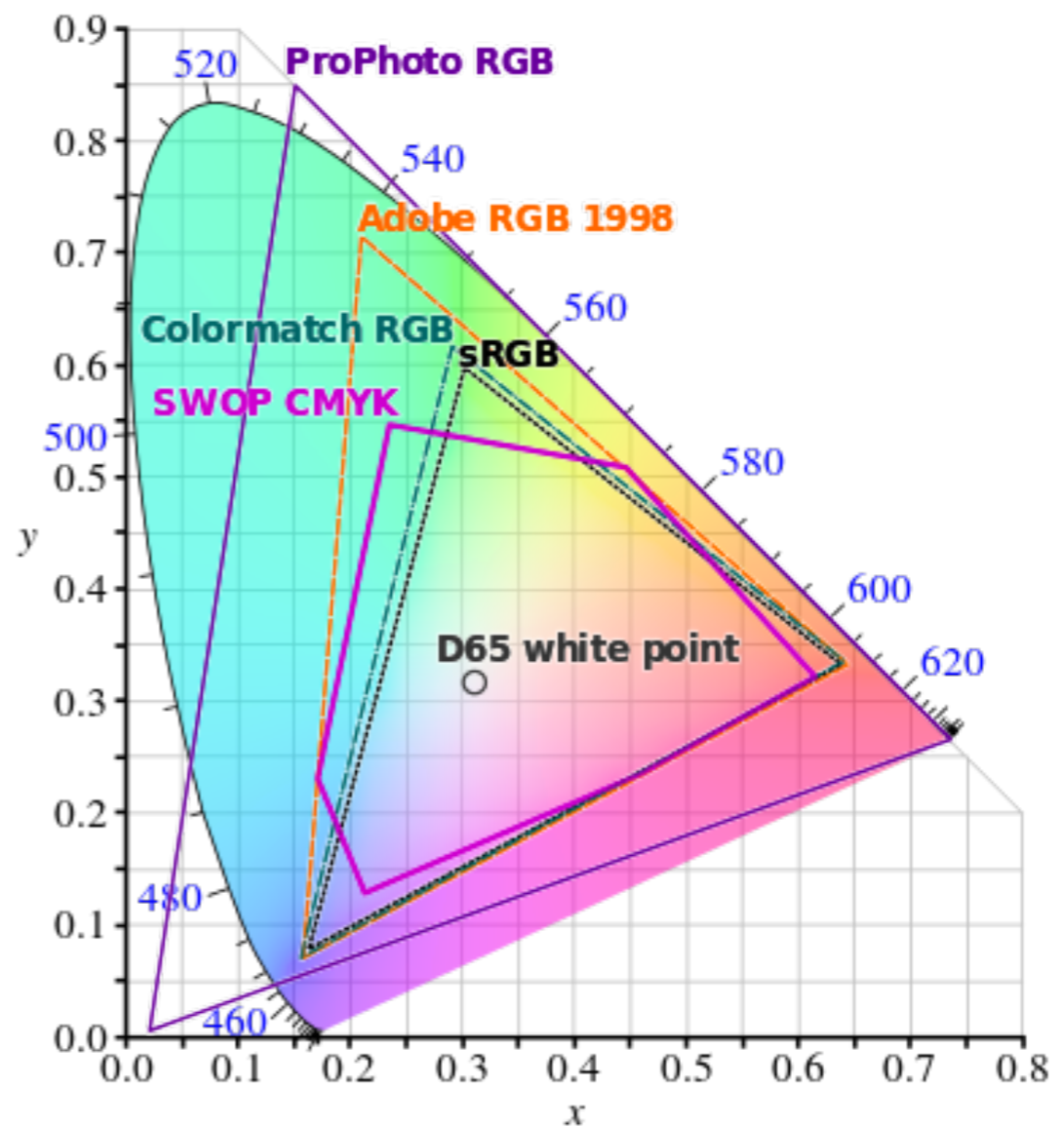


subtractive
CMYK

Color Representation



sRGB color triangle



comparison of color gamuts

Bit depth - defined by device standards

Bit-Depth	Number of Colors
1	2 (monochrome)
2	4 (CGA)
4	16 (EGA)
8	256 (VGA)
16	65,536 (High Color, XGA)
24	16,777,216 (True Color, SVGA)
32	16,777,216 (True Color + Alpha Channel)

(Note alpha)

(Humans can perceive ~10,000,000 colors)

Alpha Channel

$$\mathbf{c} = \alpha \mathbf{c}_f + (1 - \alpha) \mathbf{c}_b$$

