Multimedia Technology (IT-204-F)

Section B
Image compression & standards

Lecture 4
Color Models & Imaging Devices

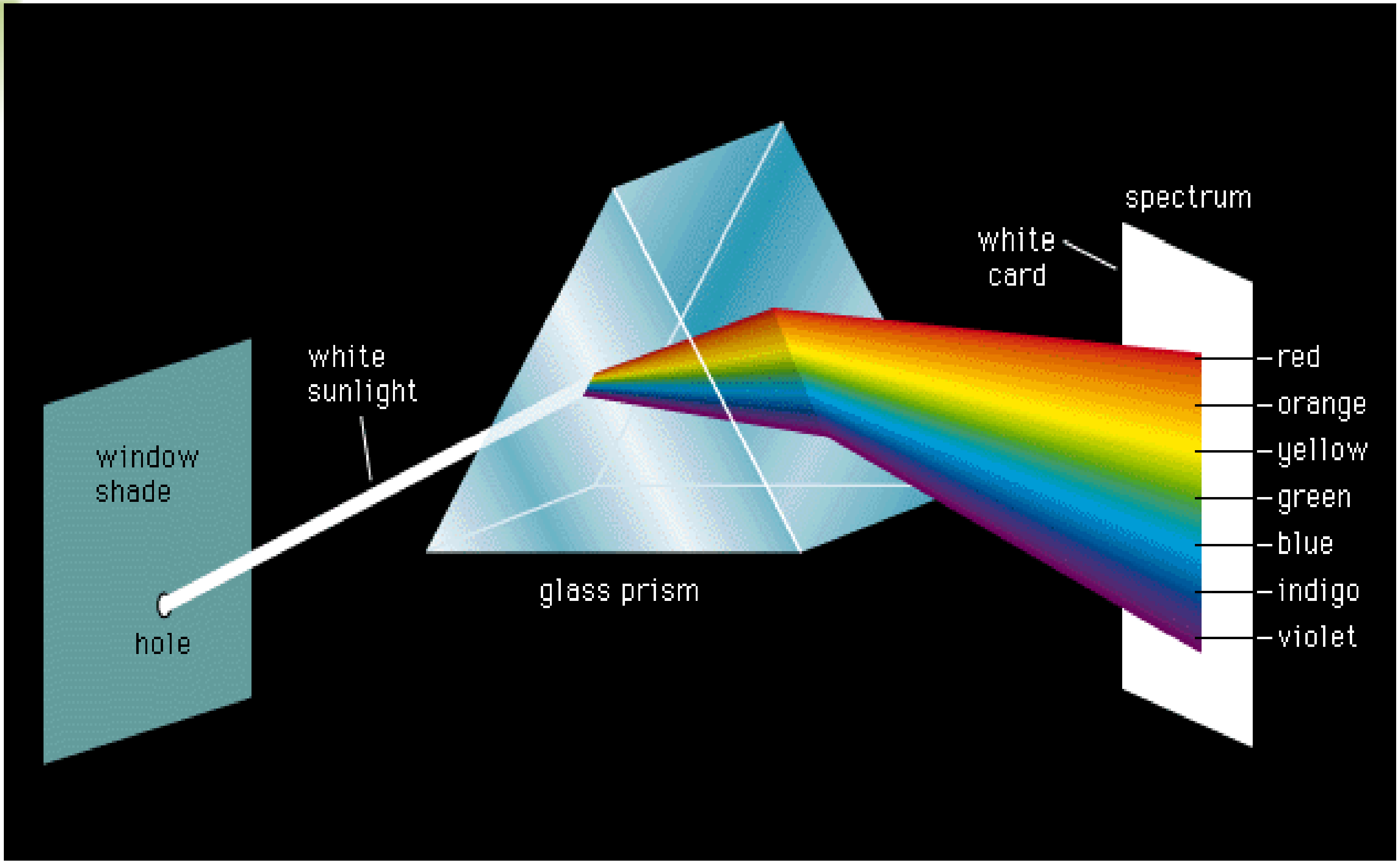
Introduction

COLORS

- The colors that humans perceive are determined by the nature of the light reflected from an object!
- Green objects reflect “green” light!
- Light is electromagnetic energy in the 400- to 700 nanometer wavelength part of the spectrum, perceived as the colors ranging through violet, indigo, blue, green, yellow, orange, and red.

3

Newton's Prism Experiment



4

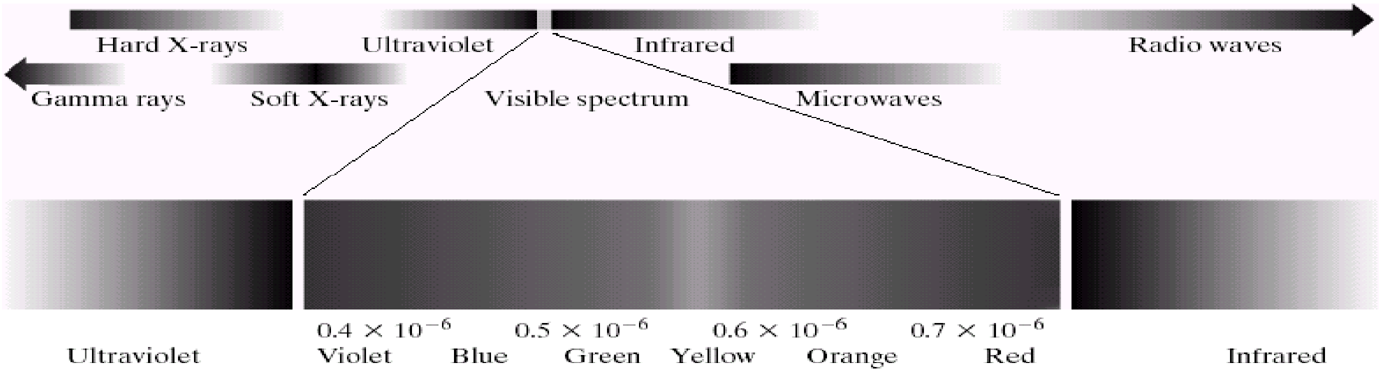
Color Terminology

- **Hue** – color
- **Monochromatic color** – a color that is created from only one wavelength. (Most colors that we experience are NOT monochromatic. They result from a combination of wavelengths. The dominant wavelength gives us our color sensation.)
- **Chrominance** – color information
- **Luminance** – lightness or brightness information
- **Additive color systems** – based on adding colored light (as in computer monitors). A combination of all colors gives white.
- **Subtractive color systems** – based on adding pigments (as in printing). A combination of all colors gives black.

Colors

- **Achromatic**: Only *intensities* (amount of light)
  - Gray levels as seen on black/white TV-monitor
  - Ranges from black to white

- **Chromatic:** Light waves; Visual range: 400nm-700nm



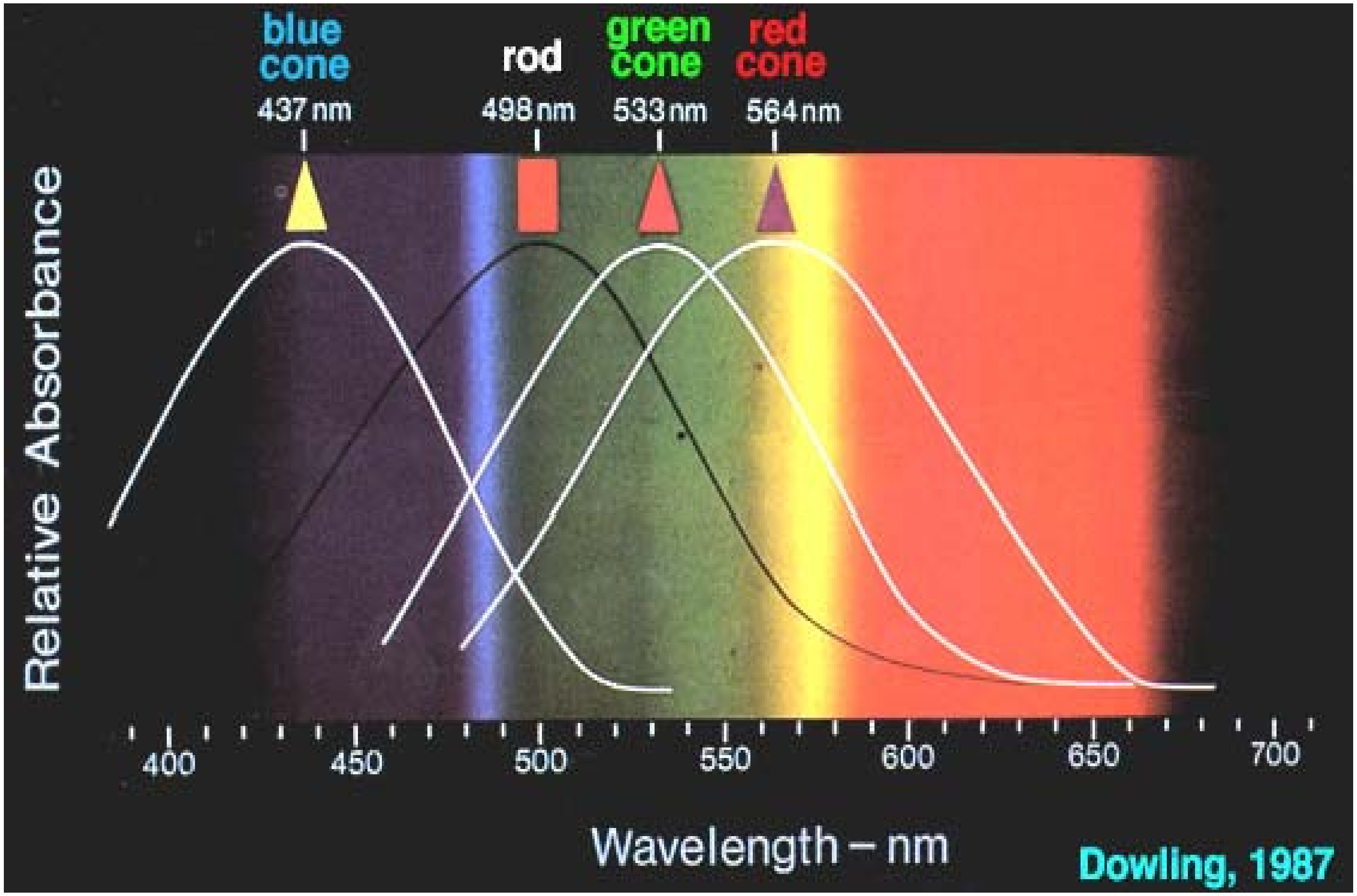
Human Perception of Color

- To humans, color sensation is a matter of subjective perception resulting from the effect of light on the cones of the eyes.

- There are three types of cones, each one with a particular sensitivity to red, green, or blue light.

- This decomposition of light into three color components is called the *tristimulus theory of color* and is the basis for the RGB color model.

Receptivity of the Eye Cells



Red, Green, Blue

- R,G,B are called **Primary Colors.**

- R,G,B where chosen due to the structure of the human eye

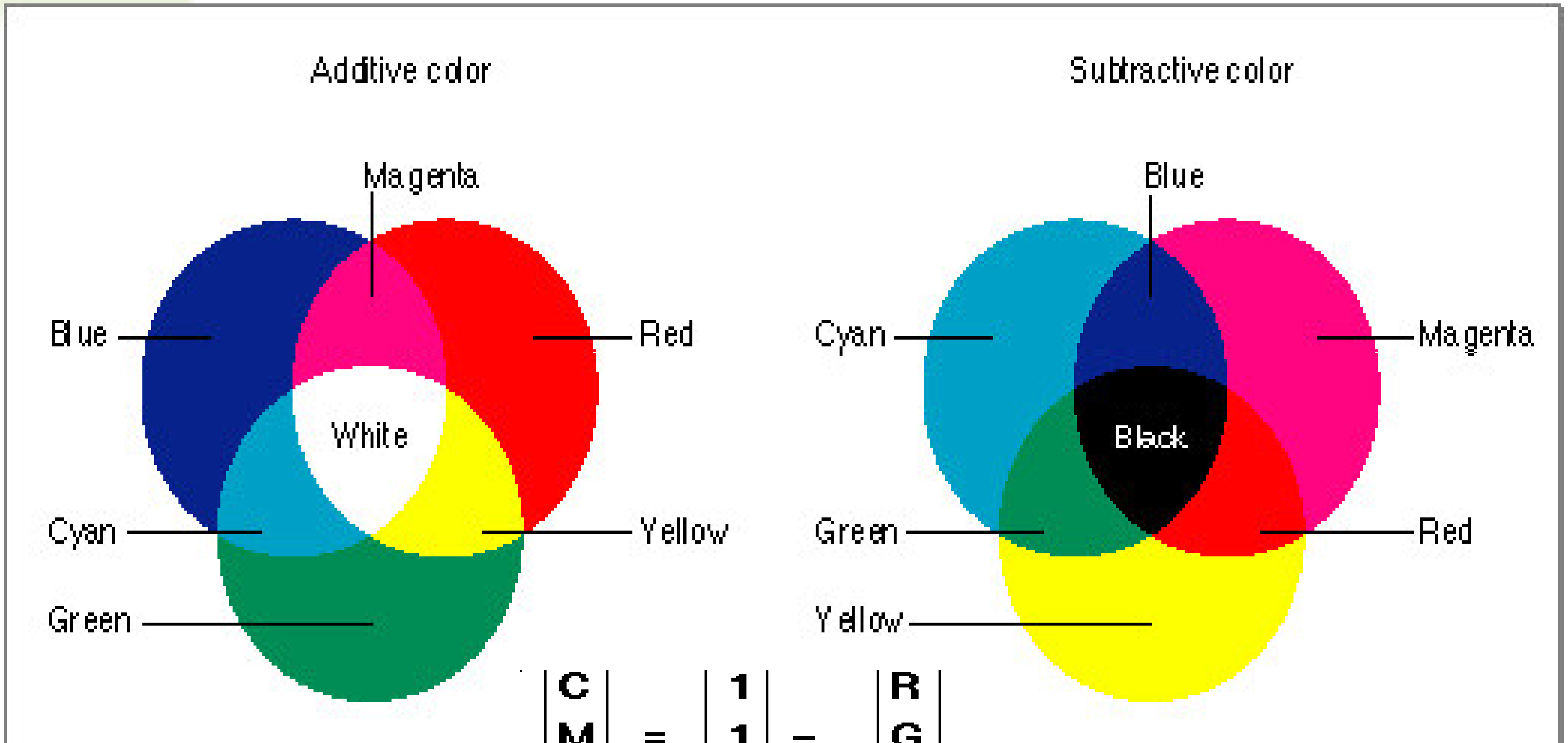
- R,G,B are used in cameras, Computer monitors.

Additive/Subtractive Color

- **Additive Color**: Sum of light of different wave lengths. That light reaches our eye directly.
  - Examples: TV, Multimedia Projector

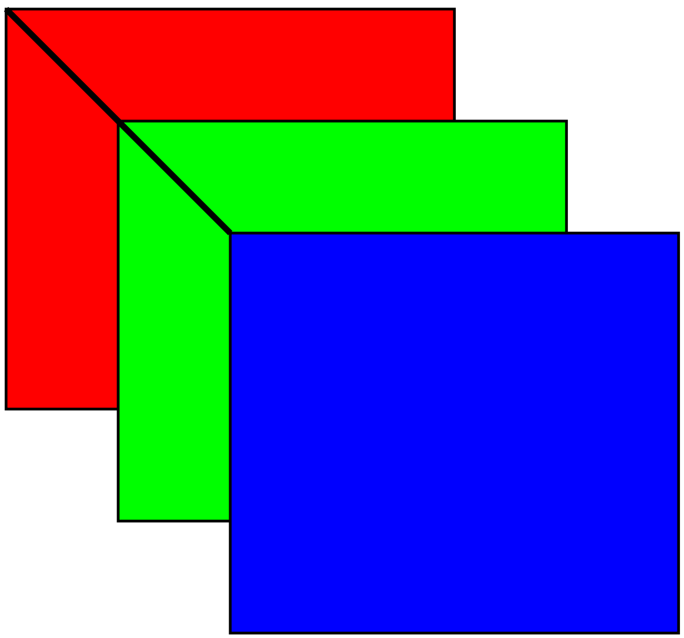
- **Subtractive Color**: White Color is emitted by the sun and is only partly reflected from an object!
  - Red paint filters all light, except red!
  - Yellow paint absorbs blue, but reflects red and green

Primary and secondary colors of light and pigments

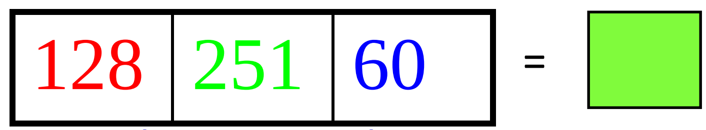


$$\begin{vmatrix} C \\ M \\ Y \end{vmatrix} = \begin{vmatrix} 1 \\ 1 \\ 1 \end{vmatrix} - \begin{vmatrix} R \\ G \\ B \end{vmatrix}$$

RGB Color MODEL/Space



A single pixel consists of three components:
Each pixel is a **Vector**.



Pixel-Vector in the computer memory

Final pixel in the image

NOTE: Sometimes pixels are not stored as vectors. Instead, first is stored the complete red component, then the complete green, then blue.

RGB Color on a Computer

- The RGB color model works well for computers because it matches the technology of monitors.

- On a color monitor, color is produced by exciting three adjacent dots made of red, green, and blue phosphors. Because the dots are so small, they are blended into one color by the eye. Note that the color is not blended by putting one color of light over another – it is blended by the eye.

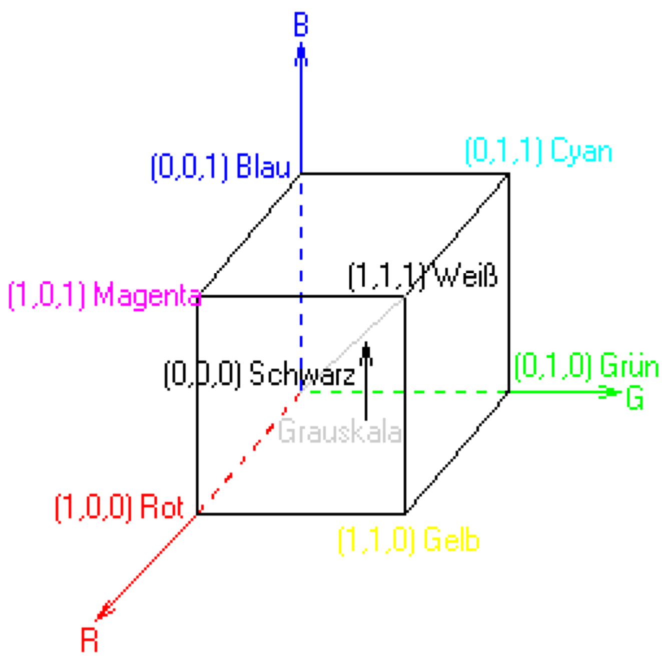
RGB Color on a Computer

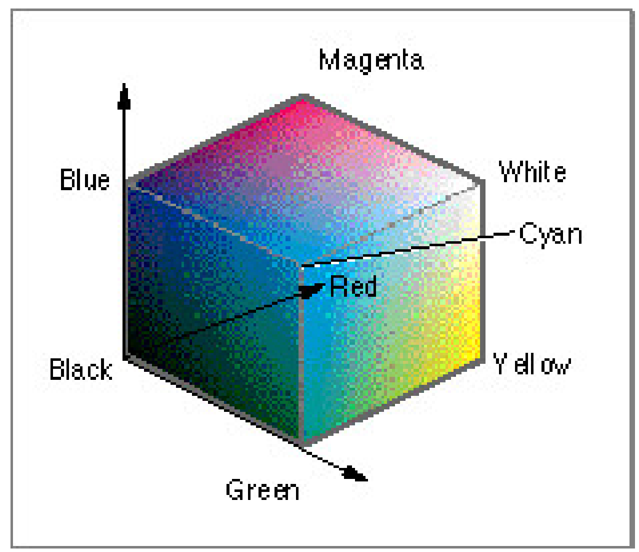
- The same RGB values will not necessarily result in the same colors on two different monitors because monitors are not calibrated to a single standard.

- RGB colors are not pure, saturated colors. This is because the kind of light emitted by an excited phosphor is not of a single wavelength.

RGB Color MODEL/SPACE

- The "classical" Computer Color space
- 3 different colors: Red, Green, Blue
- Similar to the human visual system!
- If R,G,B have the same energy, we perceive a shade of white (grey, black).

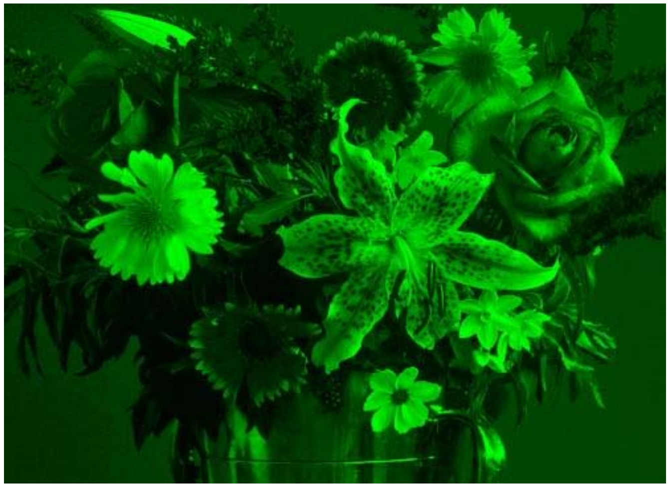




Example RGB

Original Image

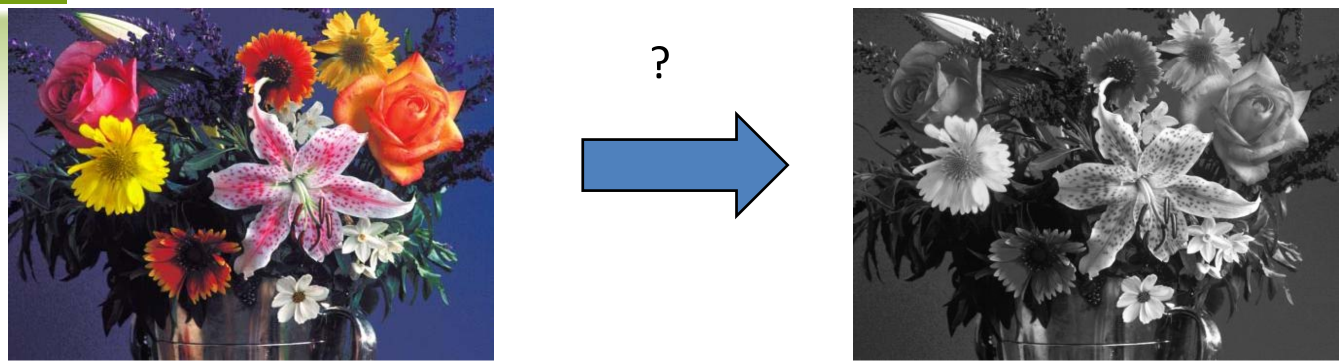
R-Component



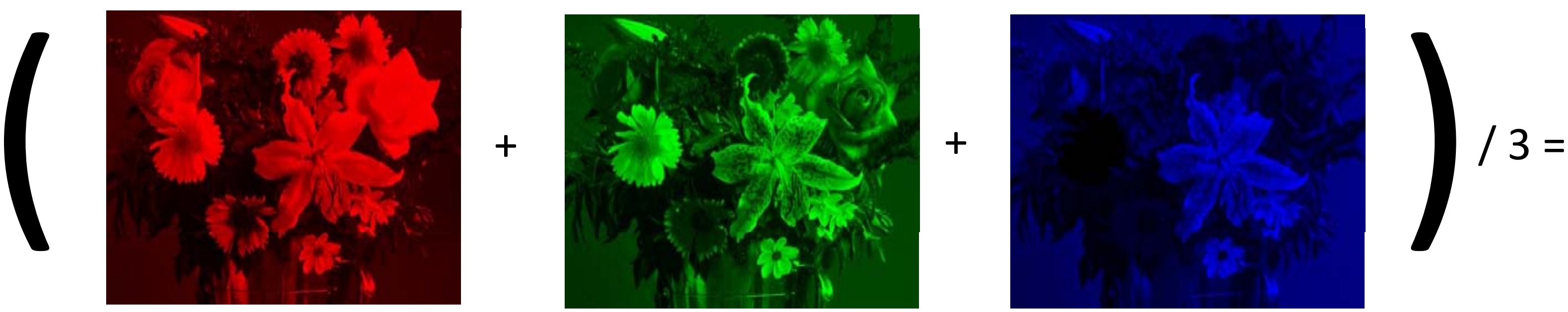
G-Component

B-Component

Convert color to grayscale



- I = (R+G+B) / 3

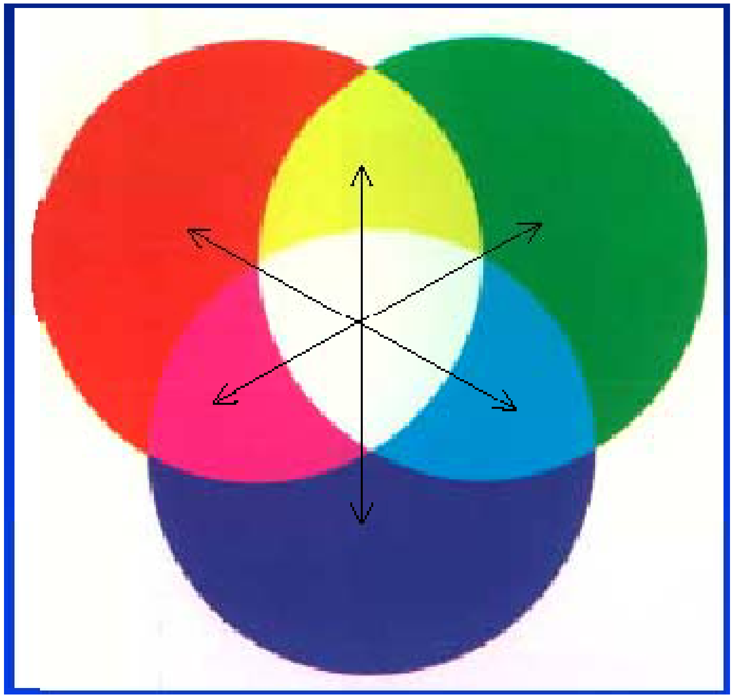


CMYK model

- CMYK is primarily a printing color model.
- Cyan, magenta, and yellow are called the subtractive primaries.
- In practice, cyan, magenta, and yellow don't produce all the colors needed for printing. Blacks come out muddy. So a pure black is added in. That's the K.

CMYK Model

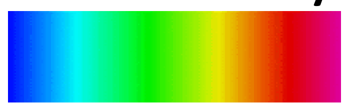
- Cyan, magenta, yellow, and black
- Cyan is white light with red taken out.
  C = G + B = W - R
- Magenta is white light with green taken out.
  M = R + B = W - G
- Yellow is white light with blue taken out.
  Y = R + G = W - B



Hue, Saturation, and Lightness

- One way to represent color is by dividing it into its *hue*, *saturation*, and *lightness* components.

- *Hue* (or color) is determined by the dominant wavelength.

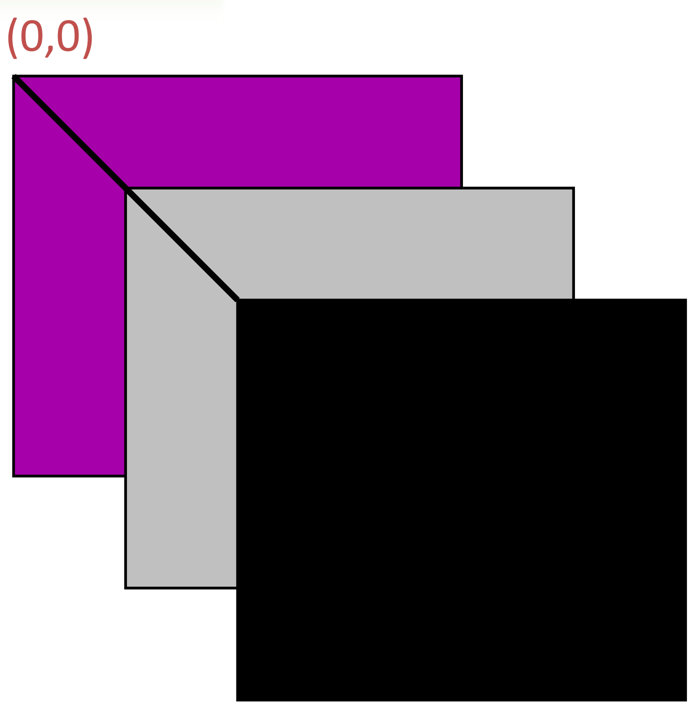


- *Saturation* is a matter of how much white light is added in. The less white light, the more saturated the color.

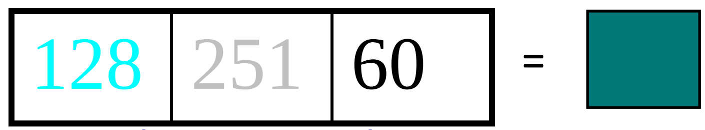
Example: Pure colors are fully saturated. Not saturated are for example pink (red+white)

- *Lightness* is how much black is in the color.

HSI Color MODEL



A single pixel consists of three components.
Each pixel is a **Vector**

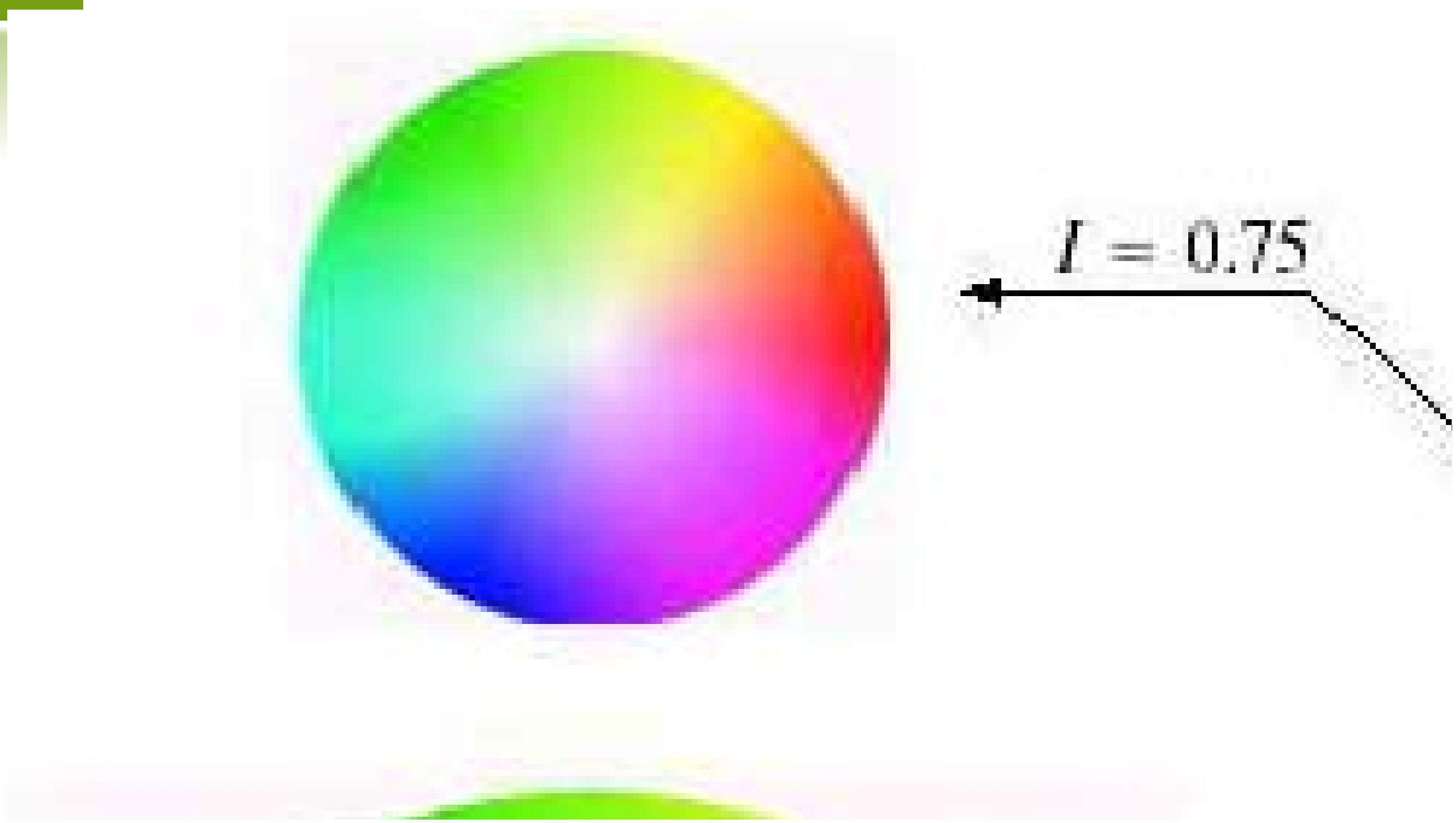


Pixel-Vector in the computer memory

Final pixel in the image

Note: Sometimes pixels are not stored as vectors. Instead, first is stored the complete hue component, then the complete sat., then the intensity.

HSI color space



- Perhaps the most intuitive color representation!
- Used in Computer Graphics (and computer vision)

Example HSI

Original Image

Hue

Saturation

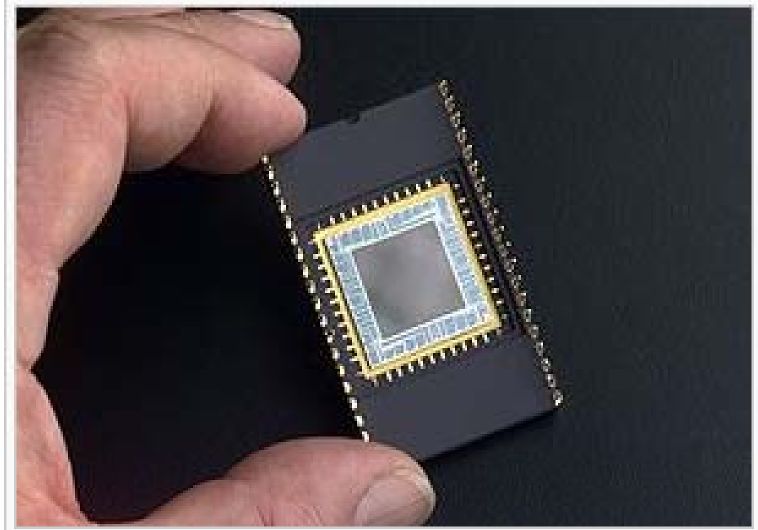
Intensity

Imaging Devices

- Charge-coupled device
- Motion picture film scanner
- Image Intensifier Tube
- Night vision device
- Bio-medical Instrument: Microfocus Dental X-ray Unit
- Digital X-ray Real-time Imaging System For Castings
- Nuclear medicine imaging
- Ultrasound Imaging and many more……

Charge-coupled device

- Charge-coupled devices can be used as a form of memory or for delaying samples of analog signals.
- "CCD" refers to the way that the image signal is read out from the chip. CCDs are used in digital photography, astronomy , sensors,medical etc



A specially developed CCD used for ultraviolet imaging in a wire bonded package.

Motion picture film scanner

•A **motion picture film scanner** is a device used in digital filmmaking .

•imaging system may be either a charge-coupled device (CCD), a complementary metal–oxide–semiconductor (CMOS) or cathode ray tube (CRT) imaging pick up.

Image Intensifier Tube

- An **Image Intensifier Tube** is a vacuum tube device for increasing the intensity of available light in an optical system to allow use under low light conditions such as at night.

- for conversion of non-visible light sources such as near-infrared or short wave infrared to visible.

Night vision device

* A **night vision device** (NVD) is an optical instrument that allows images to be produced in levels of light approaching total darkness.

* They are most often used by the military and law enforcement agencies, but are available to civilian users.

* Many NVDs also include sacrificial lenses, IR illuminators, and telescopic lenses.

* Night vision devices were first used in World War II.

Night Vision Goggle

APPLICATIONS

- Image Processing
- Image Enhancement
- Medical Imaging

Scope of Research

- Statistical Color Models
- Multi Stage Color Models