Introduction to Image Physics
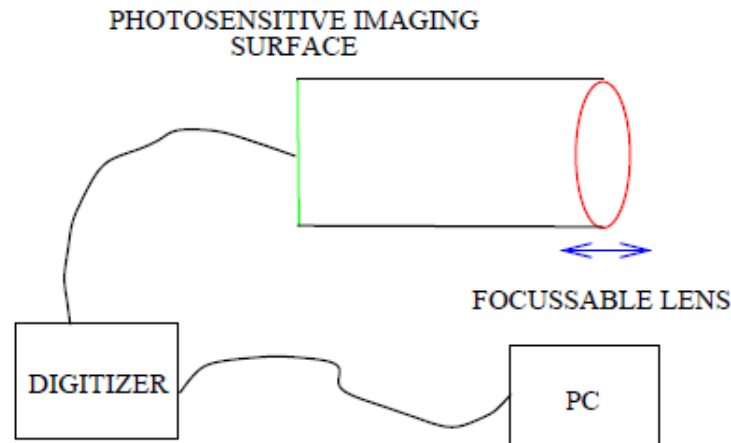
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Image Capture: Camera basics

PHOTOSENSITIVE IMAGING SURFACE
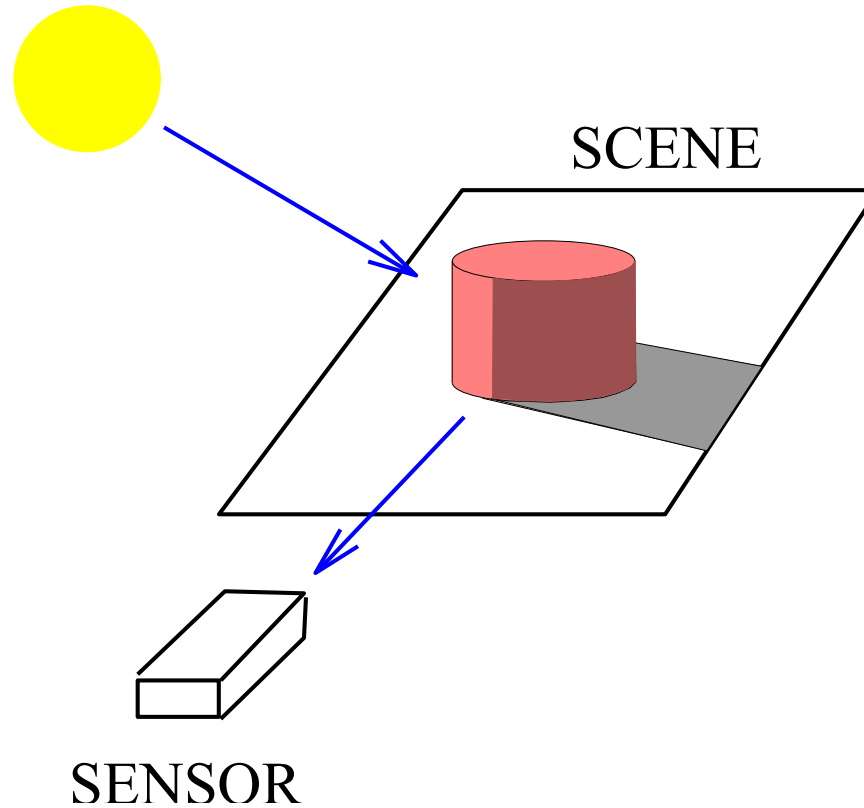
FOCUSSABLE LENS

DIGITIZER

PC

Cameras: webcam (c. 10-100 pounds).

Machine vision (500-1000 pounds).

Digitizer: comes with webcam/interface. It handles interlace, video conventions. Various PC peripheral interfaces. Only consider details for serious vision work.
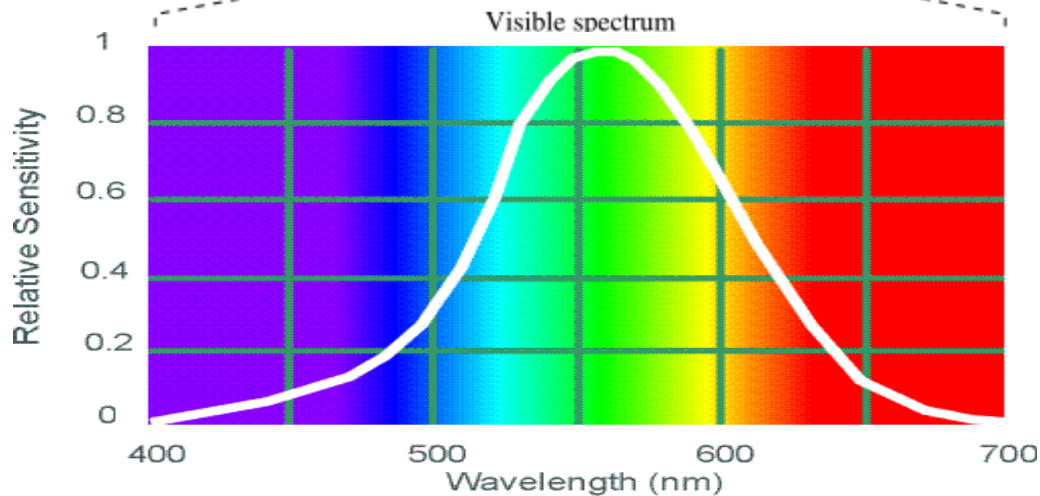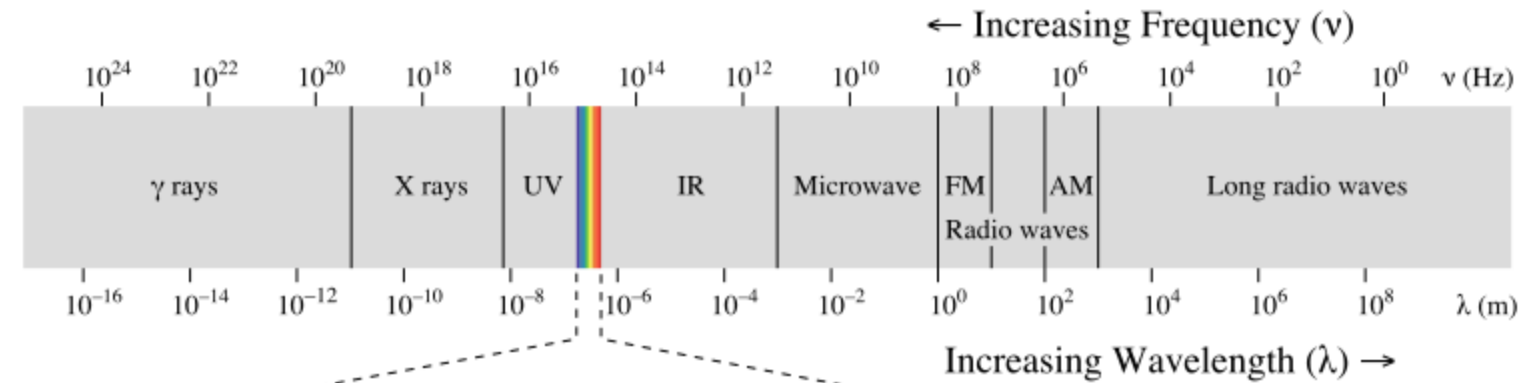
2

Image capture: elementary physics

LIGHT SOURCE

SCENE

SENSOR

Measured light is a function of source, scene and sensor properties.
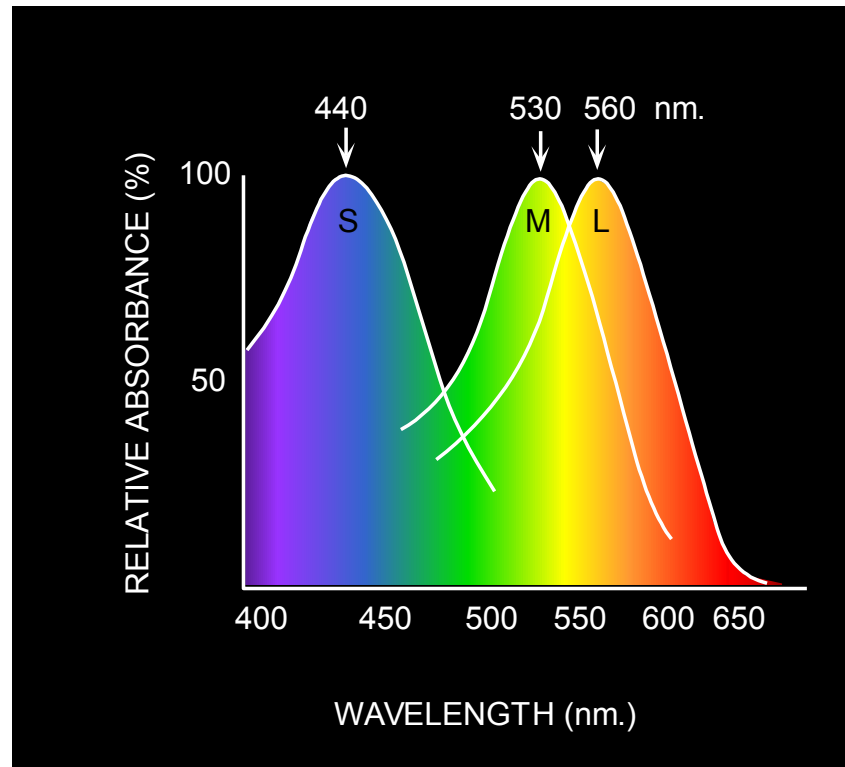
Figure by Bob Fisher

Electromagnetic spectrum
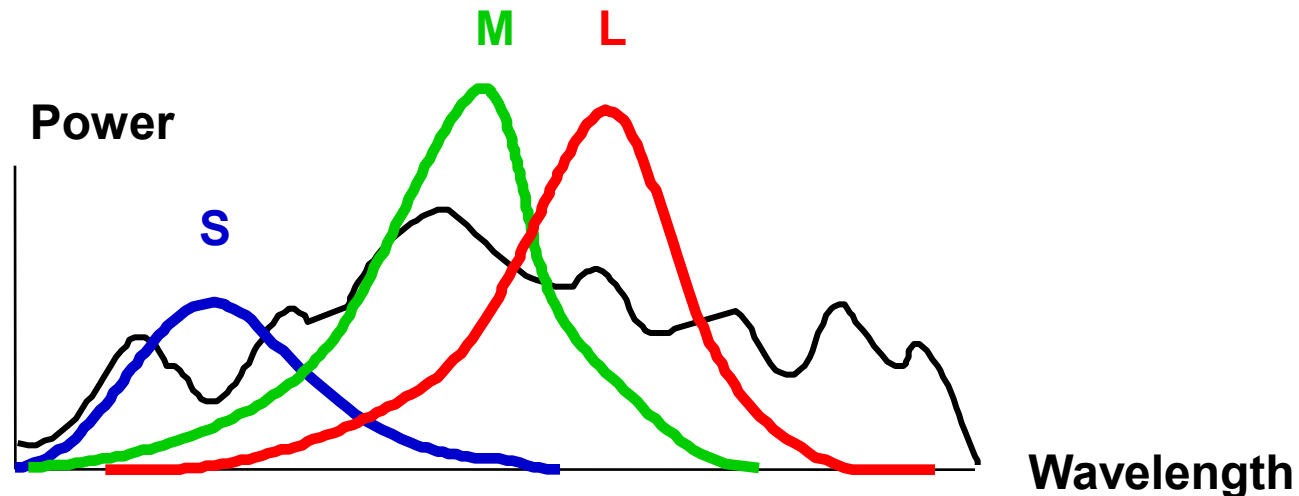

Human Luminance Sensitivity Function

Human color perception

Three kinds of cones (light sensitive eye cells)

- Ratio of L to M to S cones: approx. 10:5:1
- Blue appears 'darkest', yellow 'brightest'

Human color perception

Cones act as filters on the incoming spectrum

- To get the output of a filter, multiply its response curve by the spectrum, integrate over all wavelengths
  - Each cone yields one number

- Q: How can we represent an entire spectrum with 3 numbers?
- A: We can't! Some information is lost.
  - As a result, two different spectra may appear indistinguishable

Image Capture: Photon readout

PIXEL PIXEL

TIME   1a   1b   1c   2a   2b   2c

t1

t2

t3

...
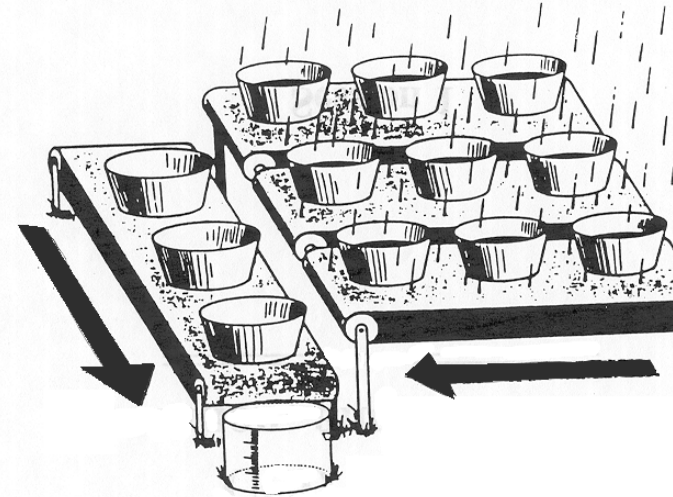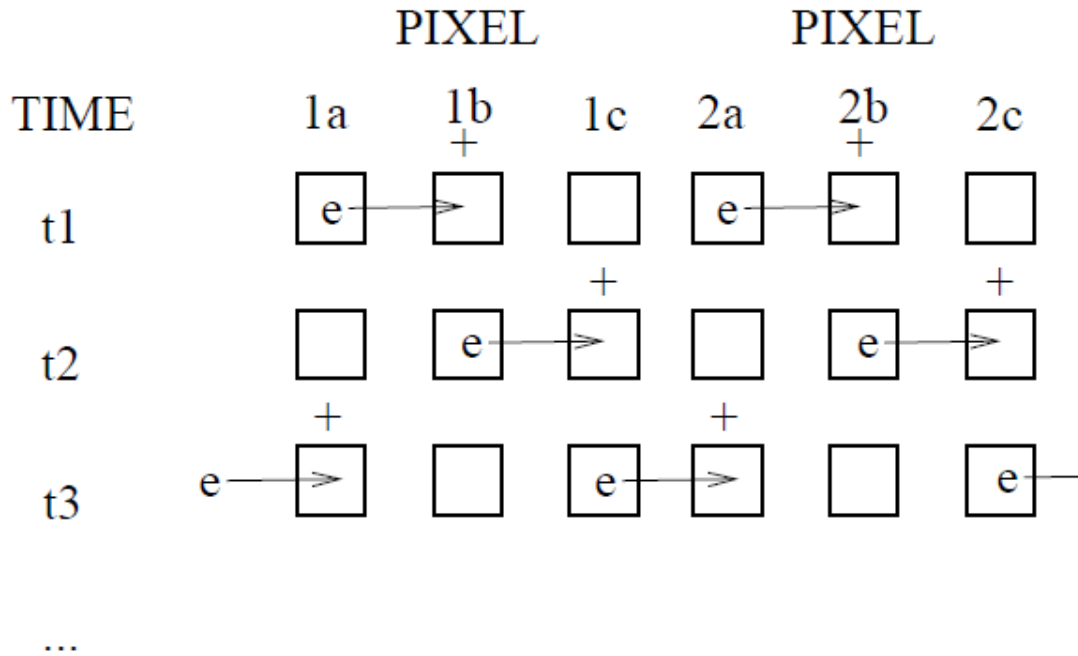
Photons converted to electrons

Shift electrons along row for readout

Three sets for 3 colours: red/green/blue

Image Capture: Matlab

```
% capture a 640x480 jpg color image and return it

function Im = liveimagejpg(filename)
  unix('mplayer tv:// -tv ...
    driver=v4l2:width=640:height=480: ...
    device=/dev/video0 ...
    -frames 5 -vo jpeg');
  unix(['mv 00000005.jpg ', filename, '.jpg'])
  Im=imread(filename, '.jpg'],'jpg');
```
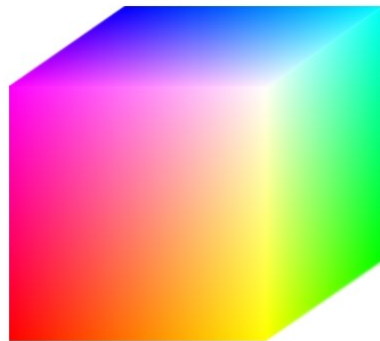
See: man mplayer
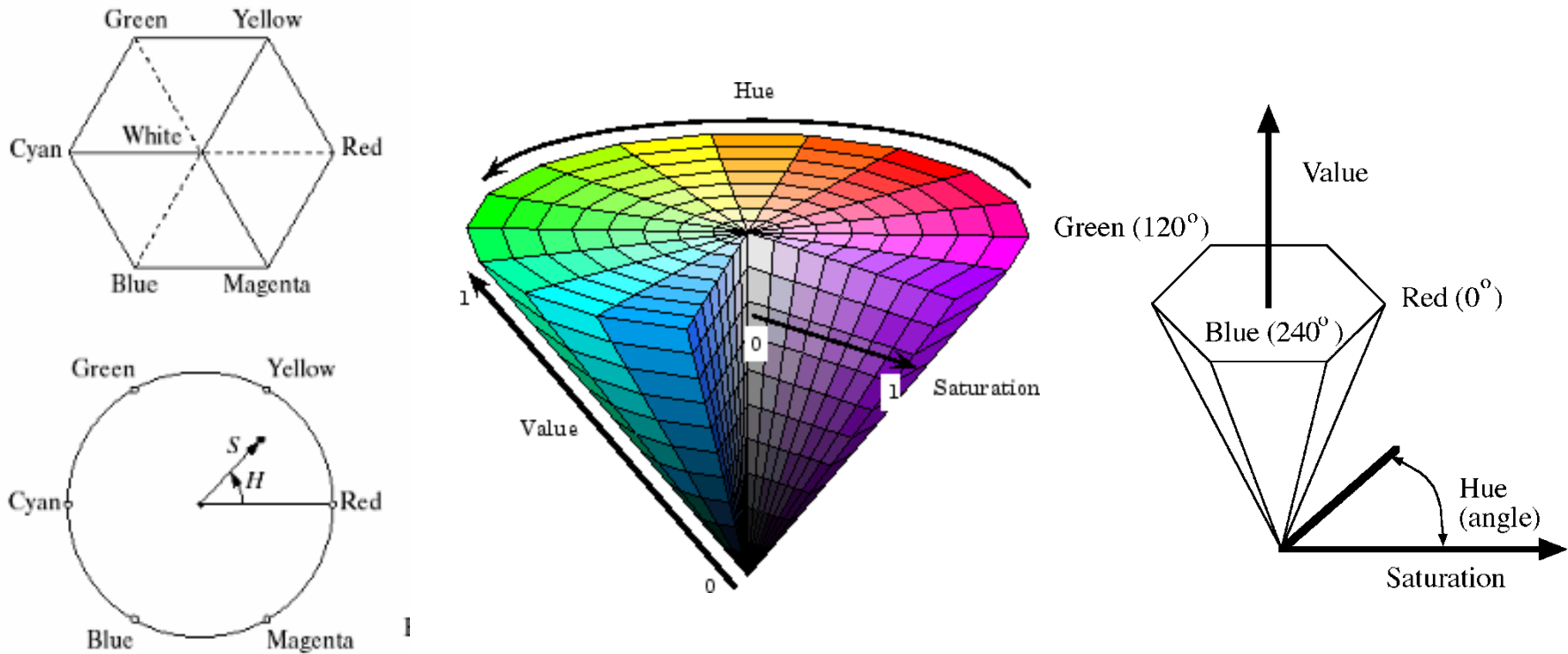
Color spaces: RGB space

- 3 primaries are monochromatic lights (for monitors, correspond to three types of phosphors)

- Linearly combined to produce other colors

- Unnatural to manipulate for humans, but good for computers to produce color

RGB primaries

p_1 = 645.2 nm
p_2 = 525.3 nm
p_3 = 444.4 nm

Color spaces: HSV space (nonlinear)

- Perceptually meaningful dimensions: Hue, Saturation, Value (Intensity)
- RGB cube on its vertex

What have we learned?

- Basics of camera and sensor operation
- Basic sensed spectrum, machine and human