Lecture 3: Image Basic

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Overview

Image Acquisition

- Image can be acquired by sensing electromagnetic waves or sound waves
- Imaging Modalities
  - Light -Optical Image
    - Analog
    - Digital
  - X-ray -X-ray and CT images
    - Analog X-ray Image
    - Digital X-ray Image
    - CT Images -Digital
  - Gamma Ray -Gamma Image
  - IR -Thermal Images
  - Radio Wave -MRI images, Satellite Images(SAR)
  - Micro Wave -To detect hidden objects
  - Ultra sound -Ultra Sound Image

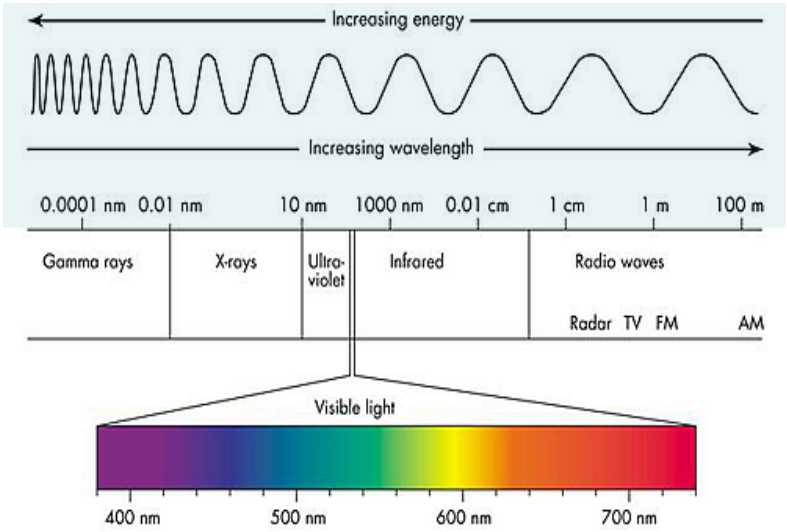


Image Acquisition using visible light on film

- Human eye is an analog camera.
- The process of computing image in human eye is incorporated in pin-hole camera.
- The image screen in pin-hole camera is a film which will get damaged when optical wave (light) hits the film.
- The damage is proportionate to the strength of light that is hitting at a position in film.

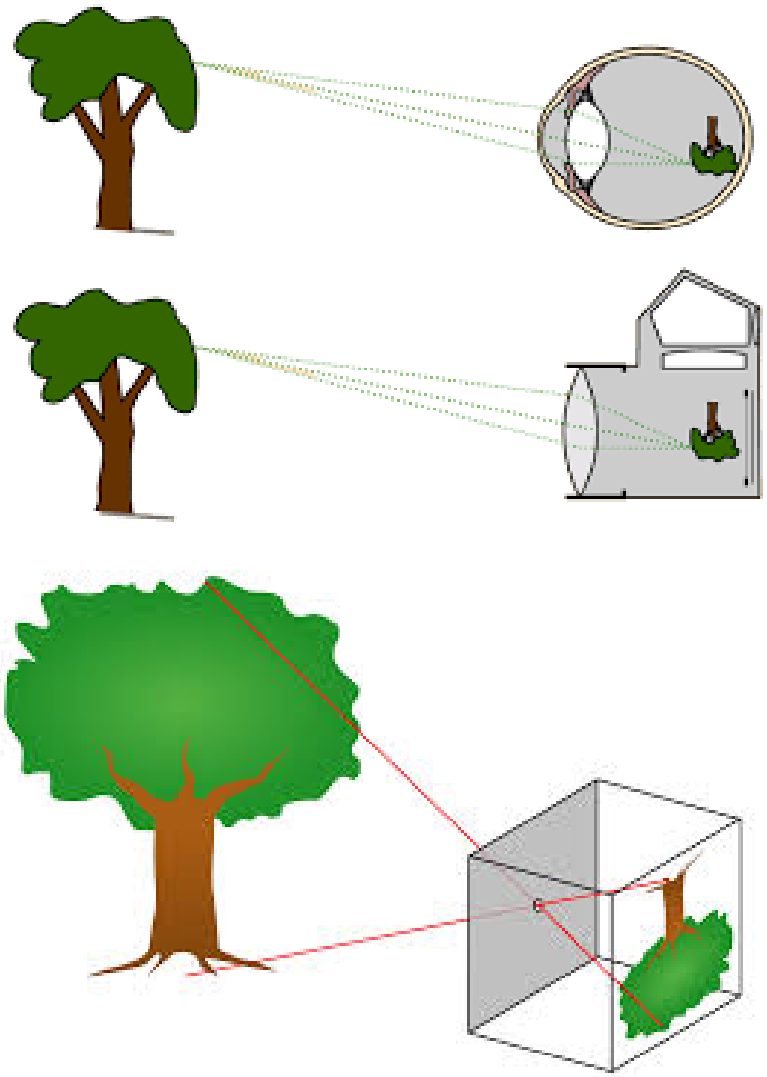


Image Acquisition using visible light on film (cont.)

- When the film is processed the complement of image is obtained in the film.
- As there is no reason why there should be gap between any two image points in the film, the image stored in film is analog
- Issue with Pin-hole camera: image is dark
  - Soln: Use lens

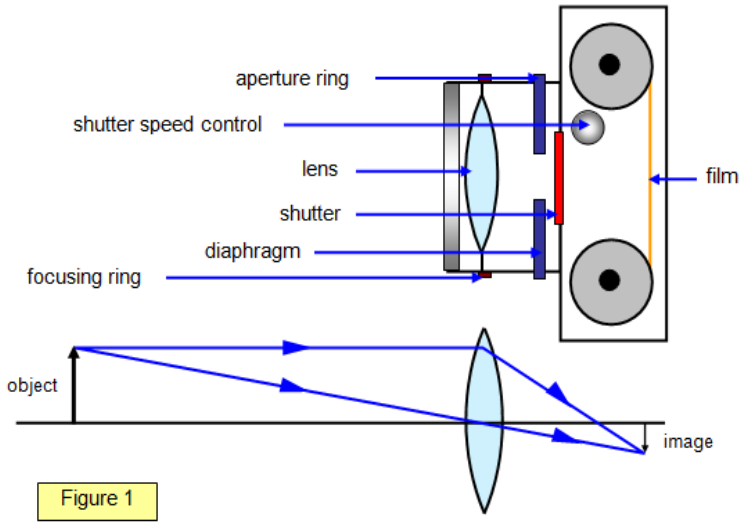
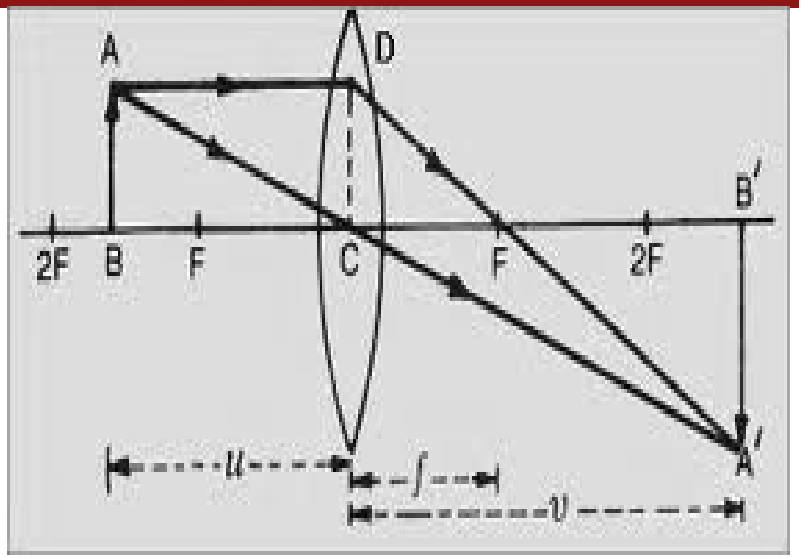


Figure 1

Image Acquisition using visible light on film (cont.)

- When will good quality image be formed?
  - When the lens formula: $1/u + 1/v = 1/f$ is satisfied
  - Where u is the distance between object and lens, v is the distance between lens and image screen
- Magnification Formula
  - $h_i/h_o = v/u$
  - Where h_i and h_o are the heights of image and object respectively



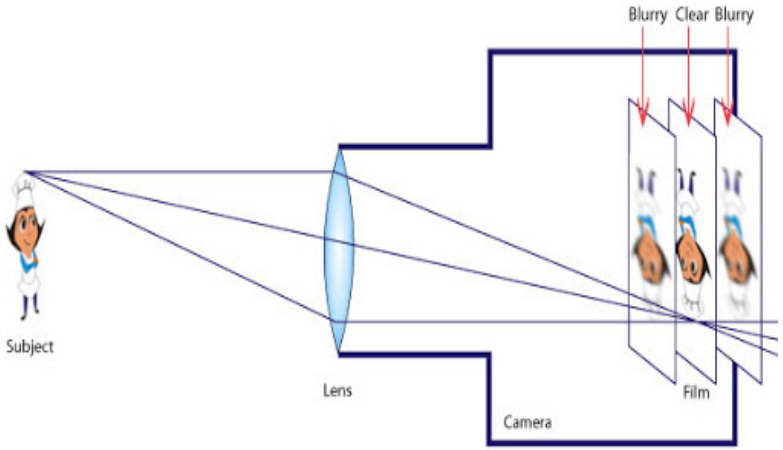


Image Acquisition using visible light with digital camera

- Digital camera uses 2D-array of sensors.
- The sensors are CCD (charge coupled device) or CMOS (Complementary Metal Oxide Semiconductor).
- Both CMOS and CCD are semiconductors, converting light signal to voltage signal.
- CMOS is required to build high speed camera(To image sports events or high speed vehicle).

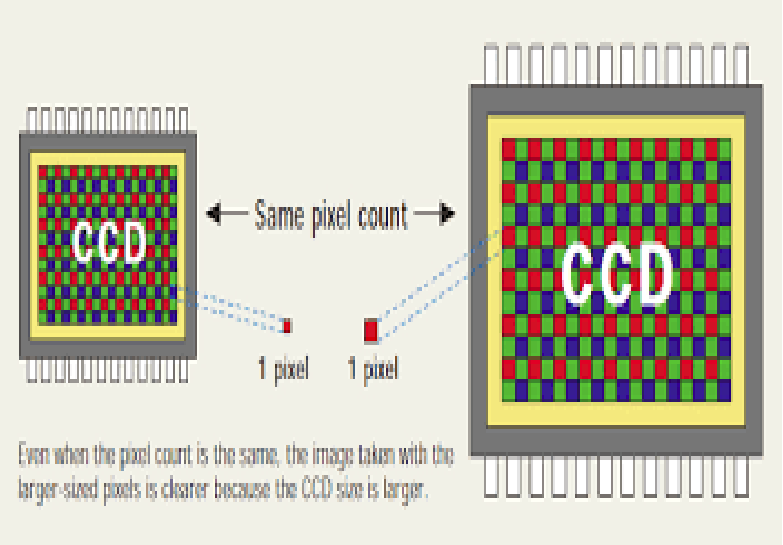


Image Acquisition using visible light with digital camera (cont.)

- Each array cell is a photo-diode, converting light intensity to voltage
- In front of each cell, there is a colour filter(RGB)
- intensity of each colour is converted to voltage

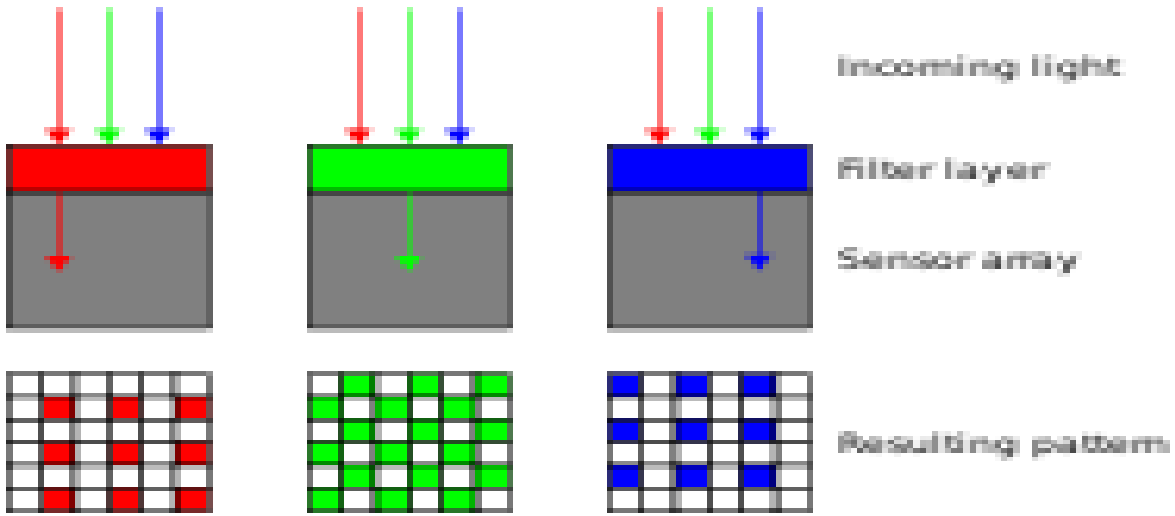


Image Acquisition using visible light with digital camera

- Digital image is a 2D-array of values, called pixel values.
- Let the pixel location be (x, y) and the pixel value at the location be $f(x, y)$.
- The value of $f(x, y)$ is dependent on two factors, namely,
  - The illumination from light source that falls at point in object corresponding to (x, y)
  - The amount of reflectively at the point in object corresponding to (x, y).
- Let us denote the reflectivity by $r(x, y)$ and illumination by $i(x, y)$.
- The range of $r(x, y)$ be $[0, 1]$.
- Zero reflecivity means black object, and one reflectivity means white object.
- The reflectivity of black velvet is 0.01 and of snow is 0.93.

Image Acquisition using visible light with digital camera (cont.)

- As a portion of amount of light which is illuminated is reflected, and the same is captured by the sensor
- The model can be given as $f(x, y) = r(x, y) * i(x, y)$. Using this model given any two of f, r and i, we can find the other one

Image Acquisition using X-ray on film

- The film based X-ray imaging has a film which will get damaged if X-ray hits the film.
- The amount of damage is proportionate to the intensity of X-ray hit at the point.
- An object to be imaged will be kept between the X-ray source and the X-ray film.
- The X-ray emitted by the object will penetrate through the object and hit the X-ray film.

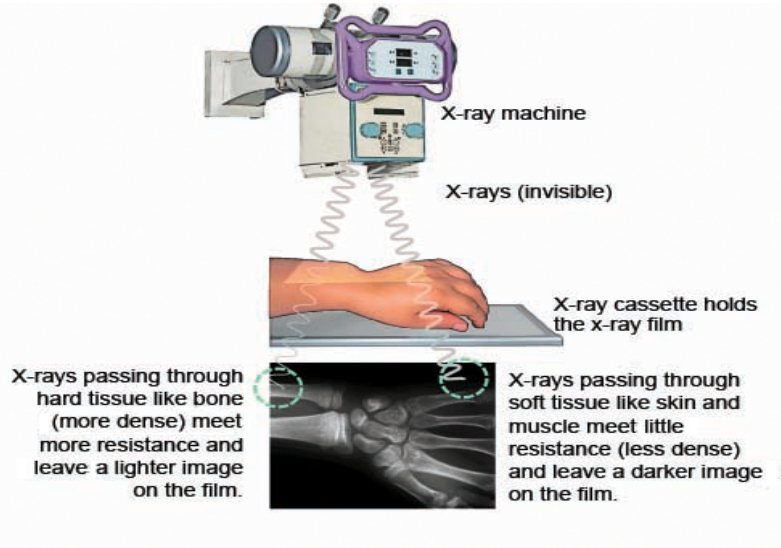


Image Acquisition using X-ray on film (cont.)

- The intensity of X-ray penetrate through the object is dependent on the hardness of the object along the line.
- After exposing the film to X-ray, the film will be processed to get the image complement(intensity black to white and white black).
- In this process, there is no reason why a particular point in X-ray film is not damaged,
- Amplitude is also non-discrete. Hence the film based X-ray image is analog image.

Image Display

- Monitors/TV
  - CRT, LCD, LED, OLED, Plasma
- Printers
  - Dot matrix, inkjet, laser
- Projectors

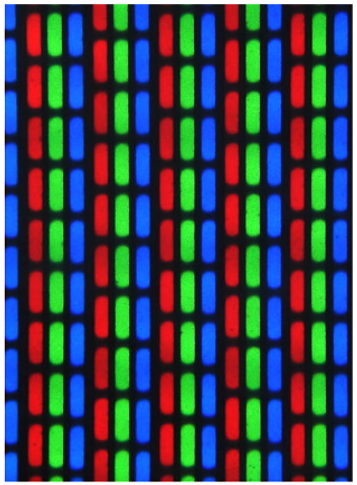
MATRIX PRINTER

VS.

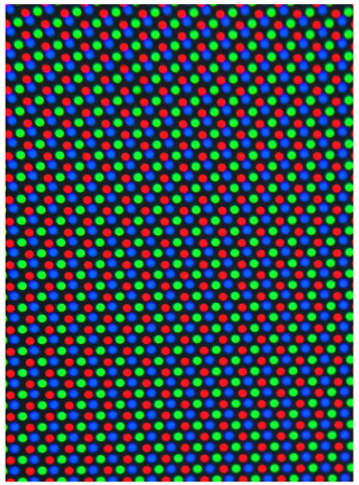
INKJET PRINTER

Image Display (cont.)

- CRT uses phosphorous coated screen
- The screen is divided into grid points
- Each grid point will have three tiny dots, where
  - The first dot is coated with one type of of phosphorous which glows in RED colour when electron hits the dot
  - The third dot is coated with one type of of phosphorous which glows in GREEN colour when electron hits the dot
  - The third dot is coated with one type of of phosphorous which glows in BLUE colour when electron hits the dot

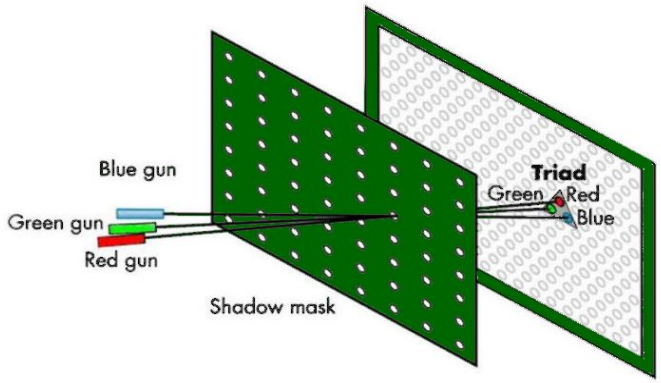


21" TV CRT Display



17" PC CRT Display

Colour CRT



Shadow mask techniques

Acknowledgements

- Images are downloaded from internet sources

Thank You! :)