Lecture 3: Photometric Image Formation Part 1

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1 Types of Sensor

There are many different types of sensors used in computer vision:

- Optical
  - CCD, Photodiodes, Photomultipliers
- Infra-red (thermal imaging cameras)
  - CCD (Cooled), Photodiodes
- Synthetic Aperture Radaaar (SAR)
  - Radar, Antenna
- Range Sensors
  - Laser & Photodiode
- MRI
  - Magnetic field gradients applied causing production of rotating magnetic field which can be measured.
- PET/CAT
  - Simulated radiation emission via magnetic field or radio isotope.

2 From Light to Images

2.1 Definitions

- ***Irradiance***: power incident on a surface (power per unit area).
- ***Radiance***: power travelling from a source (power per unit solid angle per unit projected source area).

2.2 Charge-Coupled Devices

The most common devixe for digitising image information is a charge-coupled device (CCD). They are made up of a square array of solid-state capacitors:

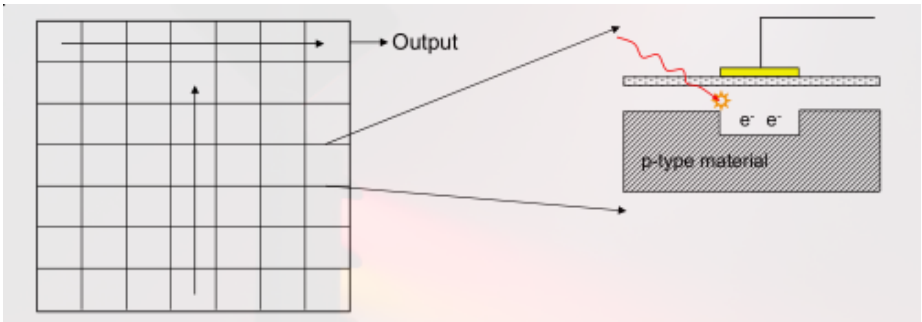

Figure 1: The flow of electrons inside a CCD

From the photo-electric effect photons of light knock out electrons from the upper plate and hence charge accumulates in the electron capture "*wells*". Using a shift register, capacitors tranfer their contents to the appropriate neighbour. The final capacitor dumps the charge for each capacitor into the analogue-digital converter (ADC). The dump happens once for each capacitor until the contents of each one has been read.

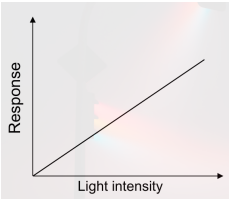

Figure 2: Ideal response of a CCD

The ideal reading from a CCD would be as simple as "$output = gain \cdot input$". See figure 2.

However, a typical reading from a CCD also includes bias and noise. ("$output = gain \cdot input + bias + noise$") The noise mostly comes from the following sources:

- Dark Cuttent - Thermal noise.
- Photon Noise - Quantum noise.
- Quantisation of pixels.
- Amplifier

See figure 3.

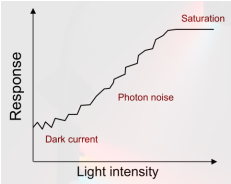

Figure 3: Typical response of a CCD