Image Acquisition

- Visual information
- Converted into electrical signals by sensors
- Sampled spatially
- Quantized in amplitude
- Result: A Digital Image

Hardware

- Vidicon tube
- Solid state imagers

Imagers

- CCD - Charge Coupled Device
- CMOS - Complimentary Metal Oxide Semiconductor
- Foveon - a chip of transparent quartz containing 3 layers of CMOS

CCD and CMOS

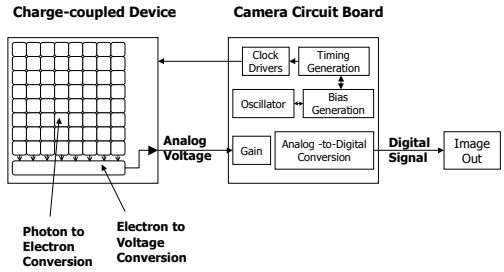
- 'Charge Coupled Device' is a description of the technology used to move and store the electron charge
- 'Complimentary Metal Oxide Semiconductor' is the name of the technology used to make a transistor on a silicon wafer

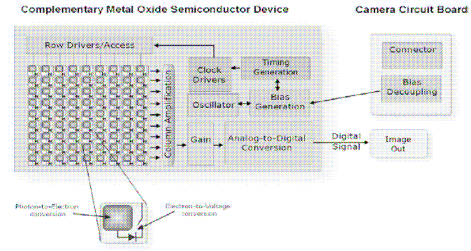
CCD and CMOS...

- pixelated metal oxide semiconductors (photo-diodes) made from silicon
- basically the same sensitivity within the visible and near-IR spectrum
- both convert the light that falls onto them into electrons by the same process
- Both cannot sense colour

The difference

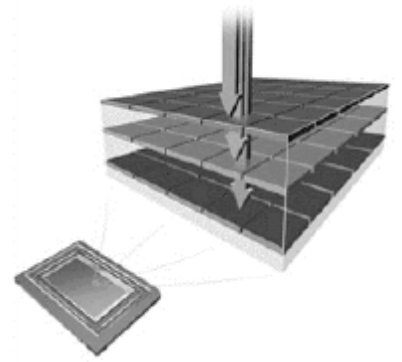
- CCD
- creates analogue signal that is digitised off the chip
- Long history of high quality performance
- CMOS
- creates a digital signal on chip
- Lower performance in past





Foveon X3 imager

- latest development
- 3 layers of CMOS imagers embedded in silicon.
- Silicon absorbs different colours of light at different depths.
- Each pixel records individual and independent values of red, green and blue, thereby providing full and accurate colour data



Sensor arrangement

- Single Sensor
- Line Sensor
- Area Sensor
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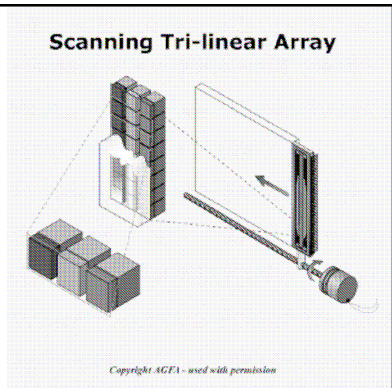
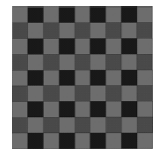
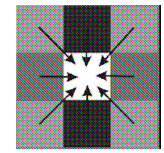
Capture Technologies

- Scanning
  - Slow, high quality
- Camera
  - Fast, less quality



Area array

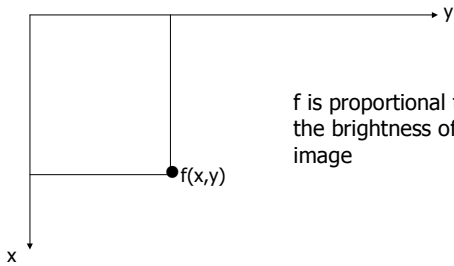




For 'one-shot' use the Area Array matrix uses three colours (Red, Green & Blue) based upon the Bayer pattern

The colour of each cell is established from a balance of itself and the colour of all its surrounding pixels

Digital representation



f is proportional to the brightness of the image

Image sampling

- Digitization of spatial coordinates (x,y)
- Divide the image area into N rows, M columns

Intensity quantization

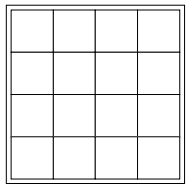
- Amplitude digitization
- For black and white images, gray level quantization

Digital Image

- B&W images can be represented in the form

$$f(x,y)=\begin{bmatrix} f(0,0) & f(0,1) & \cdots & f(0,M-1) \\ f(1,0) & f(1,1) & \cdots & f(1,M-1) \\ \cdots & \cdots & \cdots & \cdots \\ f(N-1,0) & f(N-1,1) & \cdots & f(N-1,M-1) \end{bmatrix}$$

Express this image as a matrix with 4 graylevels



$$\begin{matrix} 0 & 1 & 2 & 3 \\ 1 & 2 & 3 & 0 \\ 2 & 3 & 0 & 1 \\ 3 & 0 & 2 & 1 \end{matrix}$$

Spatial Resolution

- Pixel: Image element, picture element. Each element in the array
- Usually, M&N are integer powers of 2
- NXM is the resolution of the image

Effect of resolution

- Use Irfanview, Full screen, Ctrl+R, Alt+h on image Circle
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Effect of colour depth

- Use Irfan View, Open any photo with 24BPP, Image, Decrease Colour Depth, 8BPP, 4BPP, 1BPP
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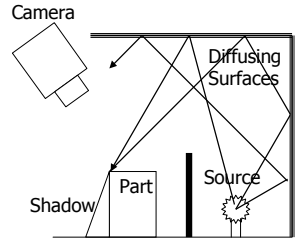
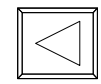
Illumination

- Diffuse lighting
- Backlighting
- Structured lighting
- Directional lighting

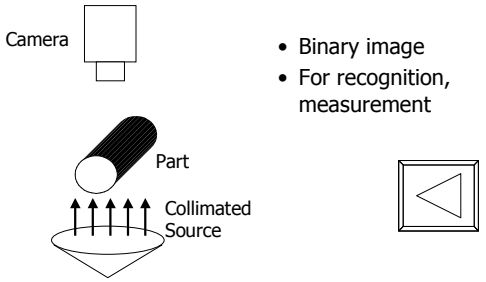
Diffuse lighting



- Smooth regular objects

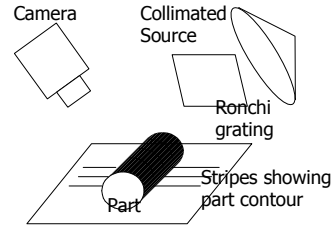


Backlighting

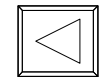


- Binary image
- For recognition, measurement

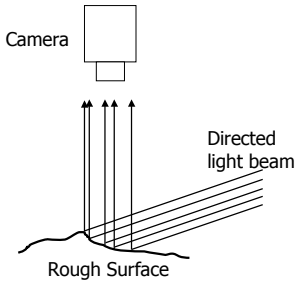
Structured lighting



- Disturbance in pattern indicates presence of object



Directional lighting



- For inspection of object surfaces

Image storage

File formats and compression