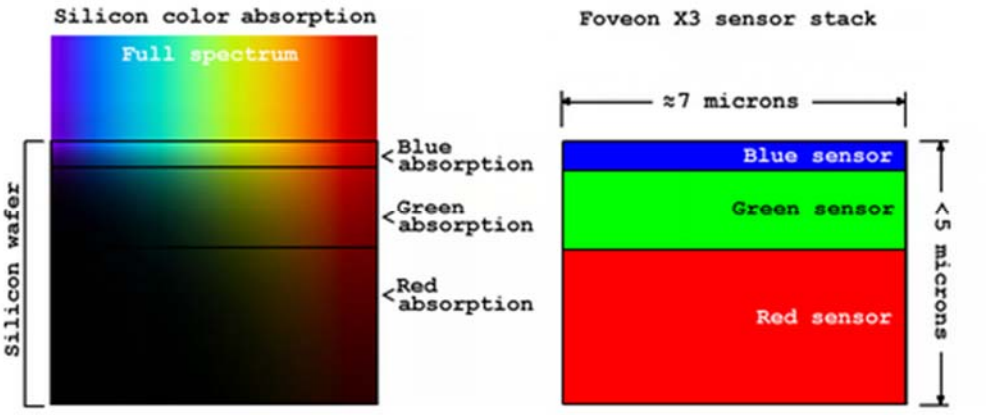
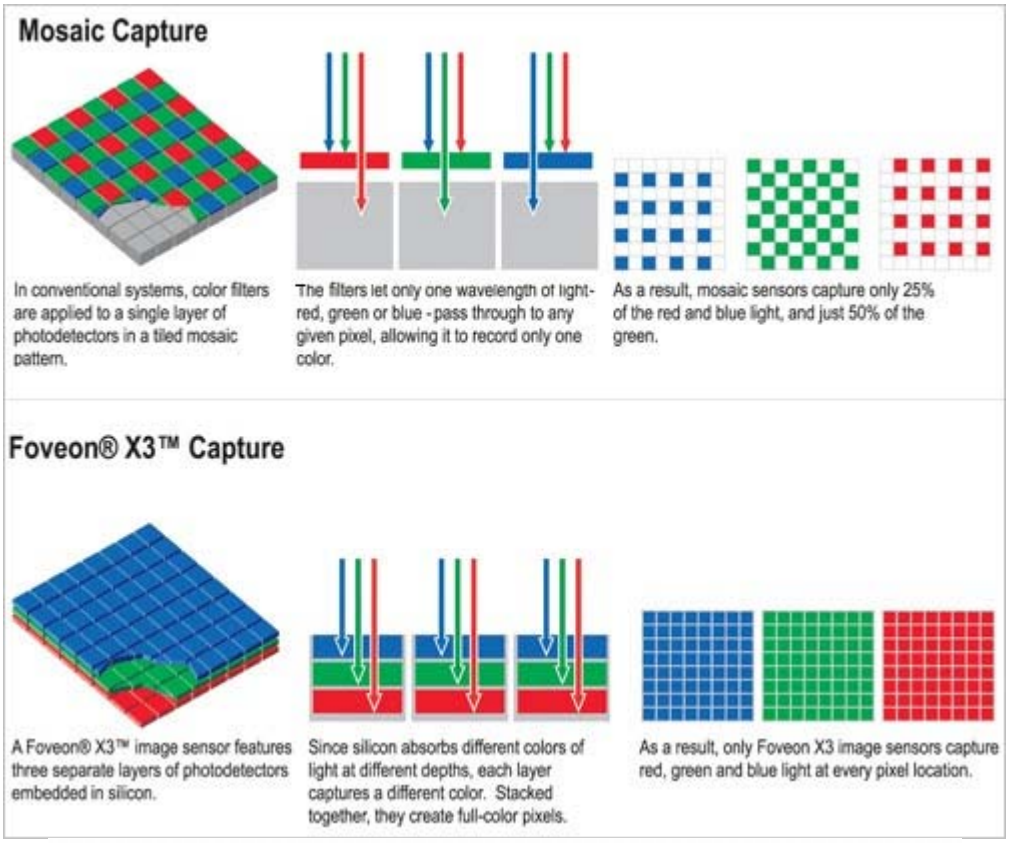
Foveon Sensor

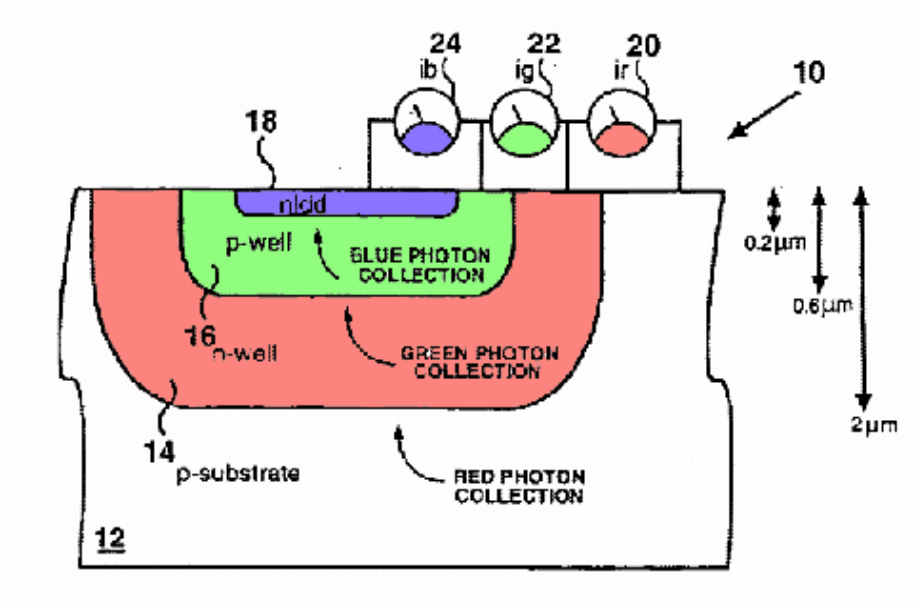
- Bayer Filter means need to interpolate colours (demosaicing)
- This results in colour error, especially at edges
- Real resolution is ¼ of the pixel count
- As with film could you get one pixel to measure all 3
- Foveon Sensor developed by Richard Mierrill in 1997
- Concept is based on depth of wavelength absorption
- short wavelengths (blue) absorbed shallow depth ,1 um
- Long wavelengths deep depth (5 um)
- Create a vertical pixel
- Implemented by Sigma as the Foveon X3 sensor



How Foveon Works

- Have 3 separate photodiodes
- Top Blue – read out blue (<1 um)
- Middle green
- Bottom Red (5 um)
- Each pixel has separate readout





Foveon Accuracy/Problems

- Foveon implemented in Sigma X3 /SD15
- Much better resolution for color
- Higher color accuracy/no edge effects
- Problem is fab is more difficult
- Makes chips yield/price higher

Demosaicing Methods

- There is no exact way to interpolate the colors
- All methods use interpolation from neighboring area
- Great if uniform color
- But fails at edges/complex image
- 3 methods
- Simple interpolation
- Statistical
- Adaptive
- Each camera manufacture uses their own method
- Also methods affect the color balance method

Bilinear Interpolation

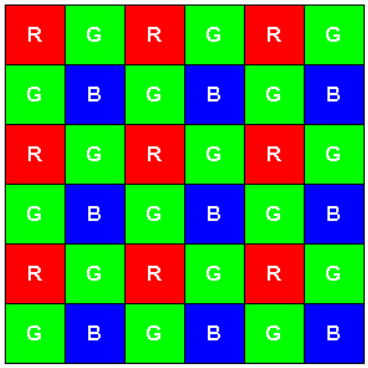
- Simplest linear demosaicing method
- estimation of the missing color is based on the neighbouring pixels
- Use the same color channels

Green:

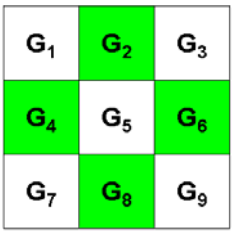
$$G_5 = \frac{G_2 + G_4 + G_6 + G_8}{4}$$

Red, Blue:

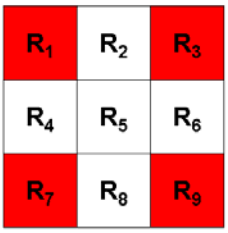
$$R_2 = \frac{R_1 + R_3}{2}; \quad R_4 = \frac{R_1 + R_7}{2}; \quad R_5 = \frac{R_1 + R_3 + R_7 + R_9}{4}$$



Bayer Color mask



Green



red and blue pixels

- Fast – low process cost
- it suffers poor image quality and moiré effect as well

Bilinear Problems

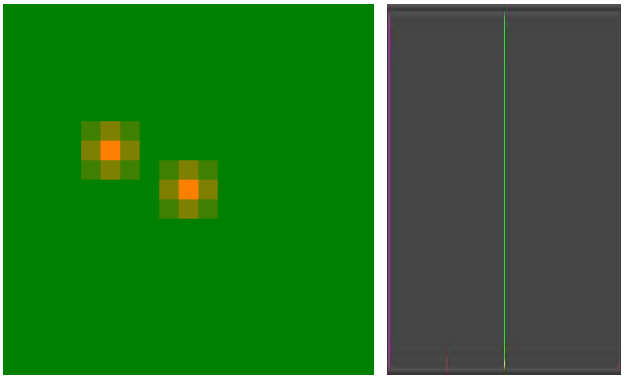
- Bilinear spread effects
- Consider a single hot pixel on black background
- Spread color causes problem
- Made worse by JPEG compression

(a) TIFF **(b) JPEG 9** **(c) JPEG 6** **(d) JPEG 3**

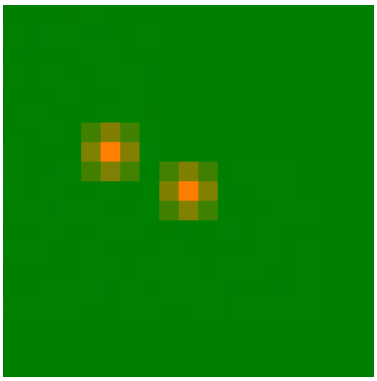
Bilinear demosaic image for red defect with I_{Offset} = 0.8.

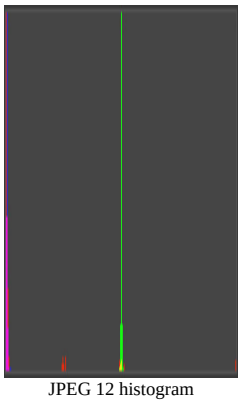
Worse With 2 bright pixels

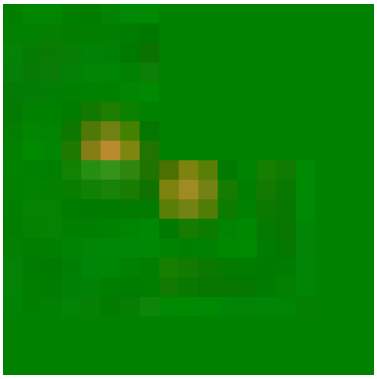
- 2 hot pixels close get overlap effects

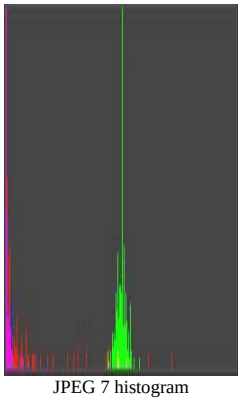

Tiff

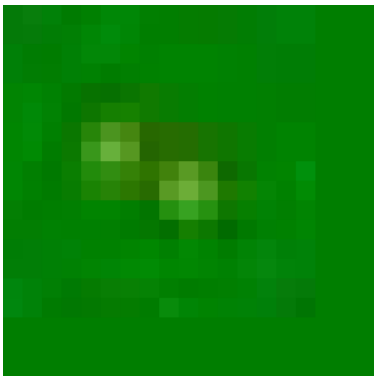
Tiff histogram


JPEG 12 (low loss)


JPEG 12 histogram


JPEG 7 (medium loss)


JPEG 7 histogram


JPEG 4 (high loss)

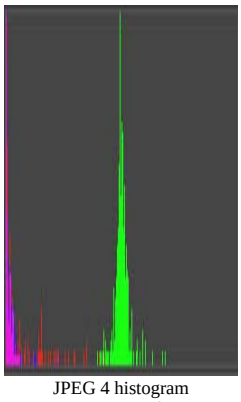

JPEG 4 histogram

Figure 6:Two Red hot pixels in 5x5 square on the diagonal with uniform green background with bilinear demosaicing in(tiff), JPEG levels 12 (low), 7 (medium) and 4 (high loss). with histogram shows color spread