

Image Histograms and Image Enhancement

Images are made up of pixels distributed in 2 D Grid

69	R: 68	R: 70	R: 71	R: 73	R: 74	R: 74	R: 71	R: 72	R: 74	R:
44	G: 43	G: 43	G: 44	G: 43	G: 43	G: 41	G: 42	G: 44	G: 54	G:
68	B: 70	B: 72	B: 70	B: 66	B: 65	B: 69	B: 70	B: 67	B: 61	B:
70	R: 71	R: 71	R: 69	R: 70	R: 69	R: 72	R: 97	R: 110	R: 121	R:
45	G: 44	G: 44	G: 42	G: 43	G: 41	G: 44	G: 64	G: 90	G: 116	G:
73	B: 70	B: 67	B: 65	B: 67	B: 67	B: 62	B: 55	B: 51	B: 41	B:
74	R: 72	R: 70	R: 69	R: 74	R: 81	R: 102	R: 132	R: 148	R: 151	R:
42	G: 44	G: 44	G: 43	G: 49	G: 64	G: 90	G: 121	G: 138	G: 144	G:
76	B: 73	B: 70	B: 68	B: 64	B: 54	B: 60	B: 35	B: 29	B: 18	B:
71	R: 72	R: 75	R: 92	R: 115	R: 150	R: 143	R: 152	R: 131	R: 153	R:
44	G: 44	G: 47	G: 70	G: 94	G: 118	G: 133	G: 140	G: 143	G: 148	G:
69	B: 66	B: 62	B: 53	B: 44	B: 23	B: 11	B: 11	B: 13	B: 18	B:
68	R: 75	R: 103	R: 129	R: 139	R: 145	R: 151	R: 153	R: 157	R: 164	R:
44	G: 56	G: 89	G: 120	G: 126	G: 135	G: 141	G: 143	G: 145	G: 150	G:
62	B: 53	B: 47	B: 42	B: 27	B: 15	B: 7	B: 8	B: 15	B: 15	B:
78	R: 115	R: 136	R: 181	R: 142	R: 151	R: 155	R: 157	R: 140	R: 144	R:
59	G: 102	G: 128	G: 124	G: 135	G: 142	G: 145	G: 146	G: 150	G: 155	G:
46	B: 45	B: 37	B: 12	B: 11	B: 18	B: 13	B: 10	B: 18	B: 30	B:
118	R: 136	R: 128	R: 141	R: 159	R: 181	R: 153	R: 140	R: 143	R: 145	R:
155	G: 127	G: 124	G: 135	G: 143	G: 145	G: 151	G: 154	G: 154	G: 154	G:
40	B: 29	B: 14	B: 7	B: 7	B: 4	B: 9	B: 19	B: 24	B: 21	B:

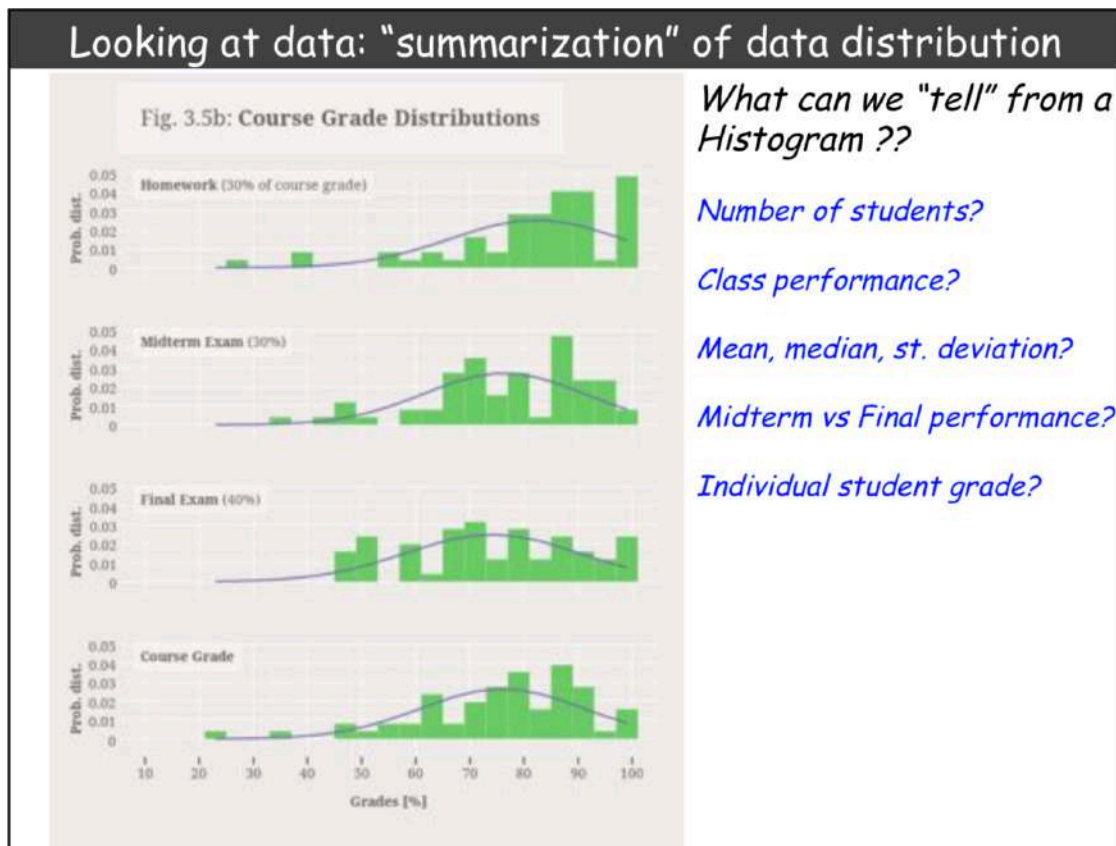
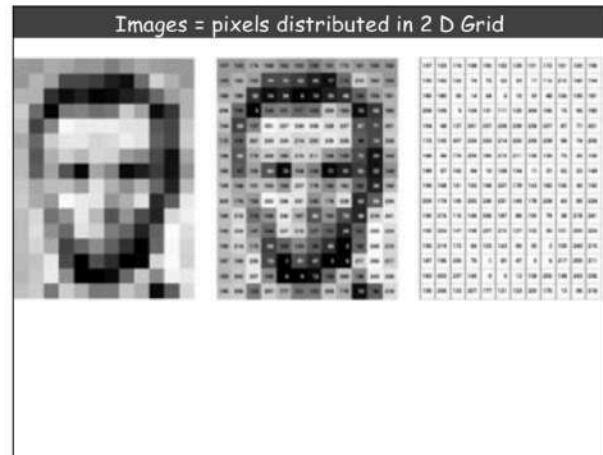
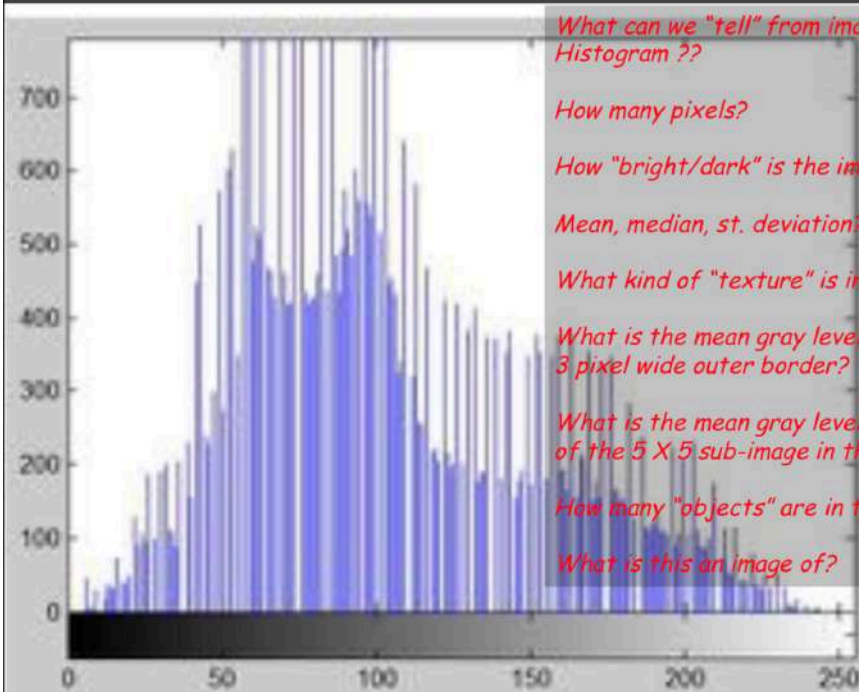


Image Histogram: How are pixel gray levels are distributed?



What can we "tell" from image Histogram ??

How many pixels?

How "bright/dark" is the image?

Mean, median, st. deviation?

What kind of "texture" is in the image?

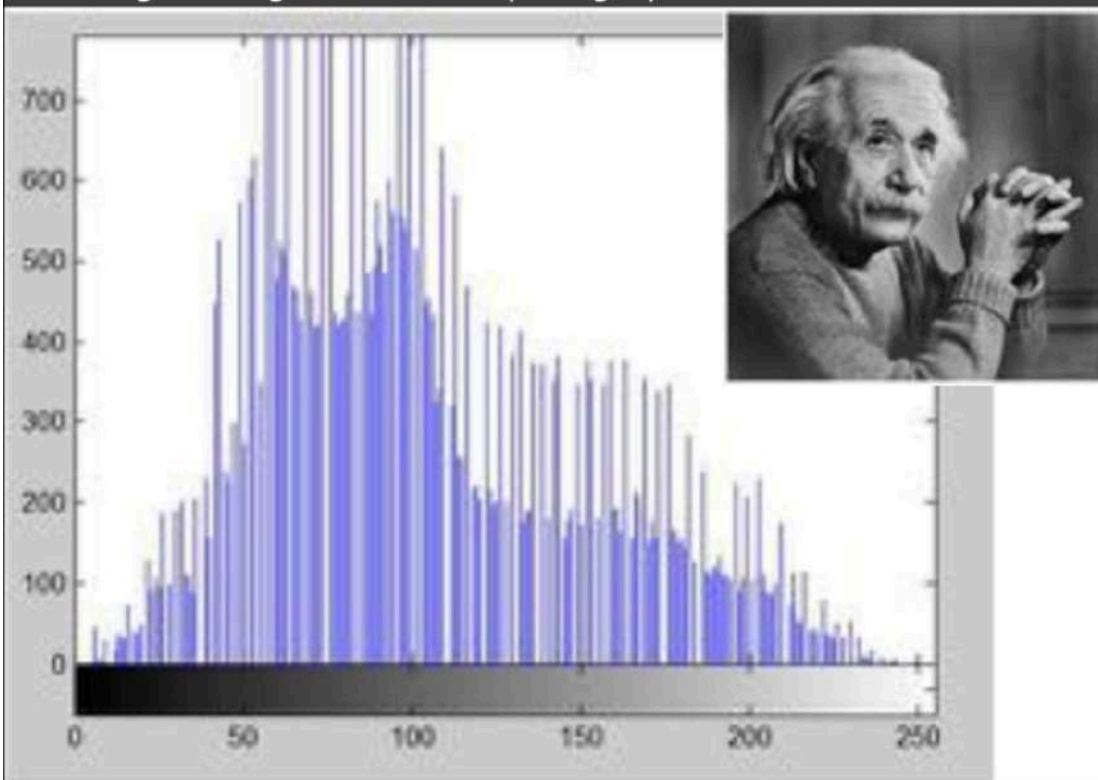
What is the mean gray level of 3 pixel wide outer border?

What is the mean gray level of the 5 X 5 sub-image in the center?

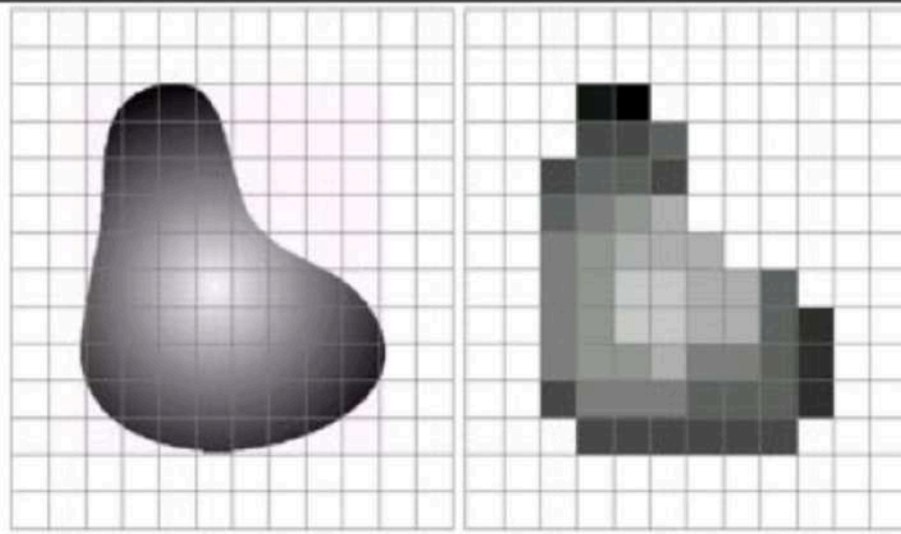
How many "objects" are in this image?

What is this an image of?

Image Histogram: How are pixel gray levels are distributed?



Sampling and Quantization



a b

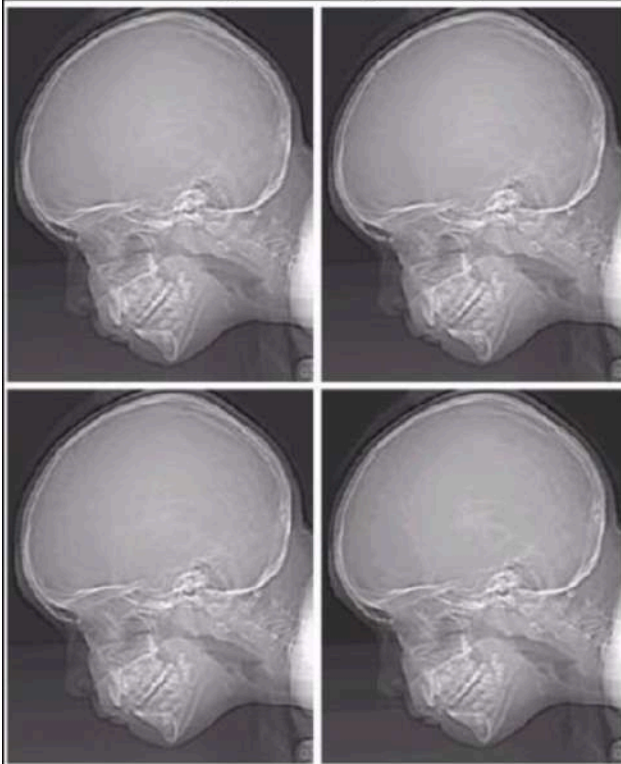
FIGURE 2.17 (a) Continuous image projected onto a sensor array. (b) Result of image sampling and quantization.

Digital Image: *Gray Level Quantization* and Histograms..



*Histograms of these images, how would they look ?
Identical? Comparable?*

Digital Image: *Gray Level Quantization Effects*



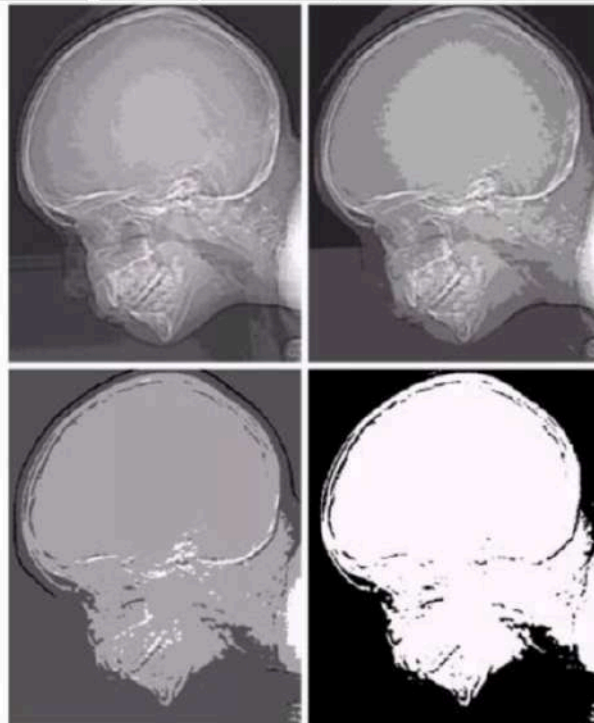
a b
c d

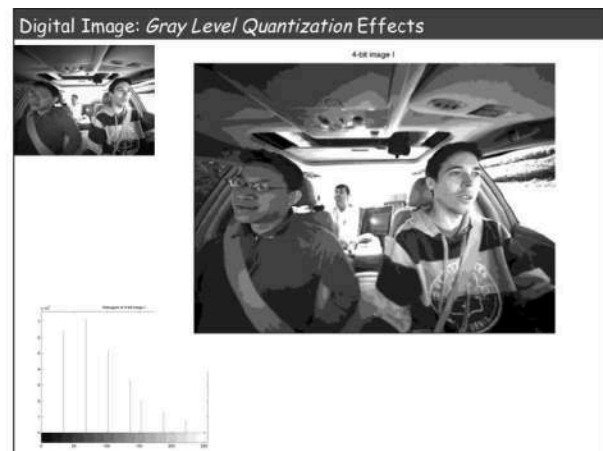
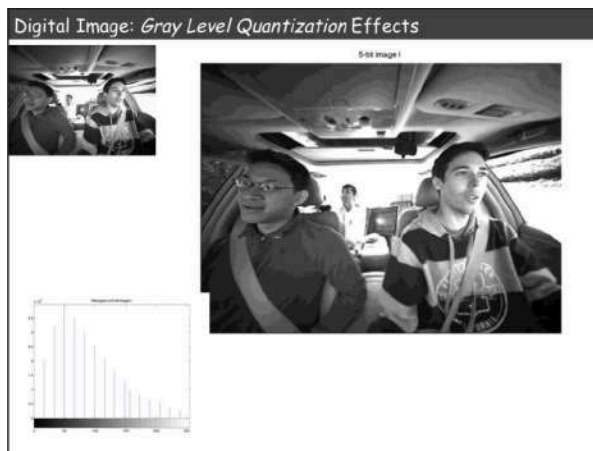
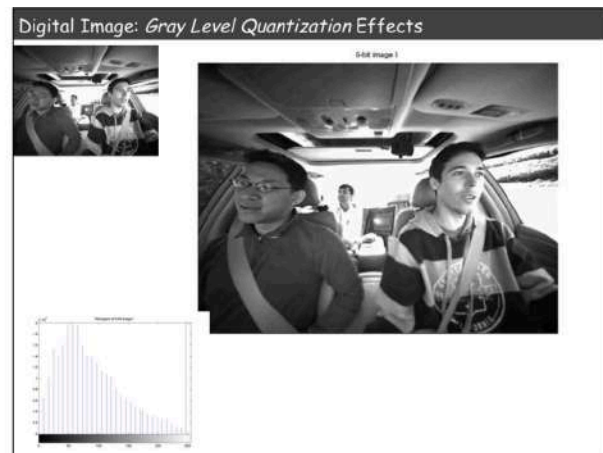
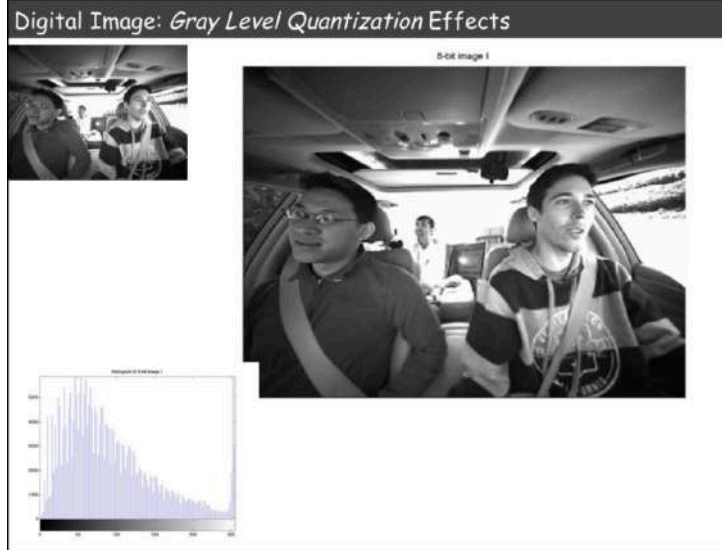
FIGURE 2.21
(a) 452 × 374,
256-level image.
(b)–(d) Image
displayed in 128,
64, and 32 gray
levels, while
keeping the
spatial resolution
constant.

Digital Image: *Gray Level Quantization Effects*

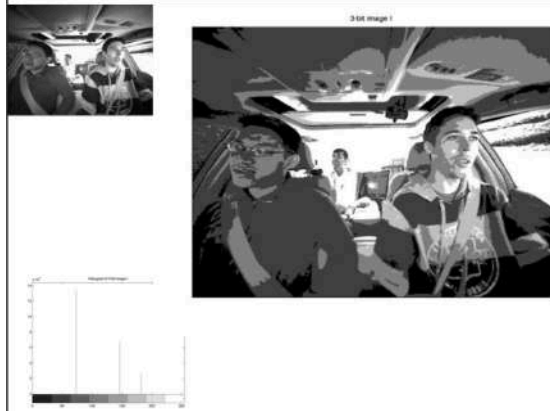
e f
g h

FIGURE 2.21
(Continued)
(e)–(h) Image
displayed in 16, 8,
4, and 2 gray
levels. (Original
courtesy of
Dr. David
R. Pickens,
Department of
Radiology &
Radiological
Sciences,
Vanderbilt
University
Medical Center.)





Digital Image: *Gray Level Quantization Effects*



Digital Image: *Gray Level Quantization Effects*



Digital Image: *Gray Level Quantization Effects*



Digital Image: *Spatial Resolution Effects*

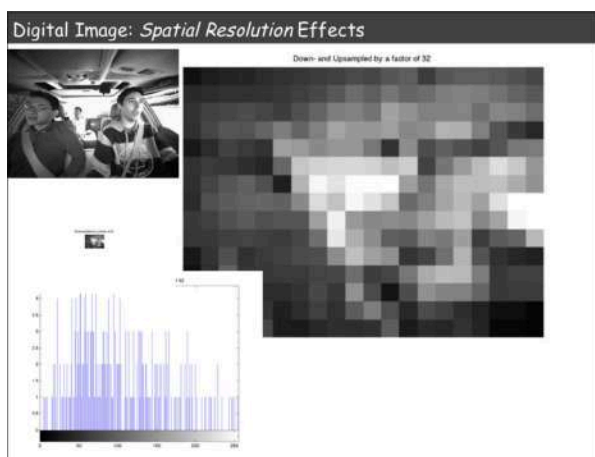
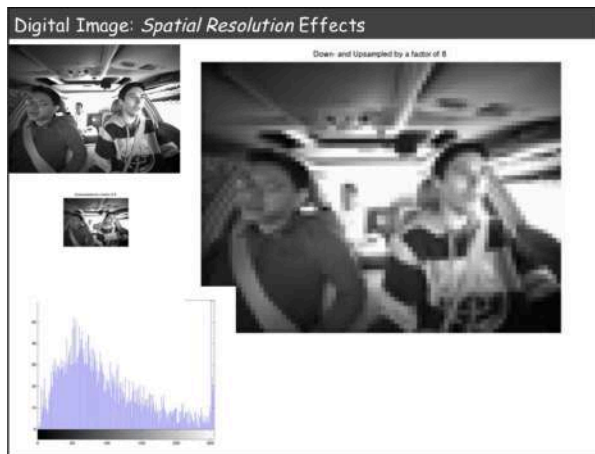
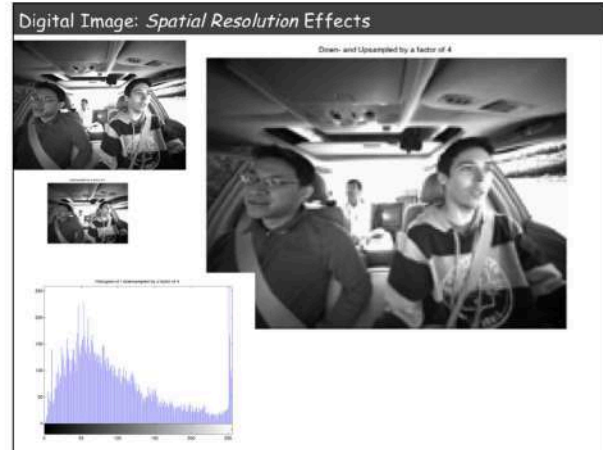
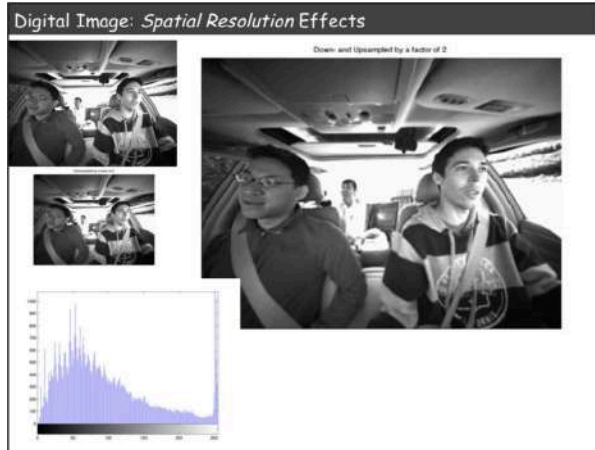


Digital Image: *Spatial Resolution Effects*

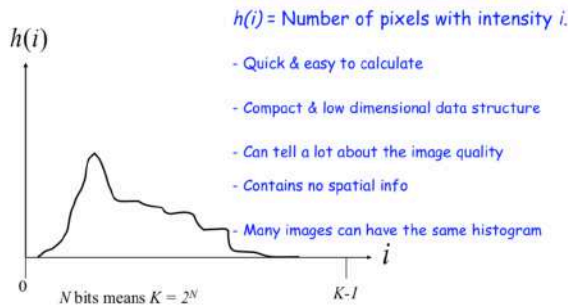


Digital Image: *Spatial Resolution Effects*





The Grayscale Histogram



From: Prof. B. Royson
Website: <http://www.rpi.edu/~roysonb>
Course Website: <http://www.ecse.rpi.edu/censsis/BioCourse>

Assessing Image Properties

"Bi-modal" histogram indicates that there are two major kinds of pixels in the image

Perhaps, two kinds of objects in scene - one kind brighter than the other

If we generalize this a bit, we arrive at the idea that a histogram is really a "mixture distribution"

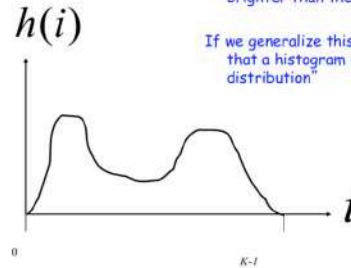


Image "Quality", Image Histograms, Image Enhancement

"Understanding image histograms is *probably the single most important concept* to become familiar with when working with pictures from a digital camera.

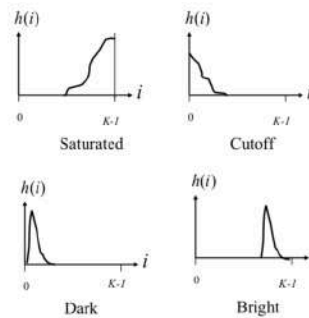
A histogram can tell you

whether or not your image has been properly exposed, whether the lighting is harsh or flat, and what adjustments will work best.

It will *not only improve your skills on the computer, but as a photographer as well.*"

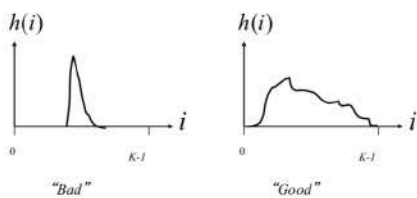
<http://www.cambridgeincolour.com/tutorials/histograms1.htm>

Assessing Image Quality



From: Prof. B. Royson
Website: <http://www.rpi.edu/~roysonb>
Course Website: <http://www.ecse.rpi.edu/censsis/BioCourse>

Assessing Image Quality



"Compact" histogram → poor utilization of available dynamic range

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Course Website: <http://www.ecse.rpi.edu/censsis/BioCourse>

Image "Quality", Image Histograms, Image Enhancement



<http://gallery.photographyreview.com/showphoto.php?photo=61131&size=big&cat=&page=9&sort=2>





Image "Quality", Image Histograms, Image Enhancement

The region ("dynamic range") where most of the brightness values are present is called the "tonal range."

Tonal range can vary drastically from image to image, so developing an intuition for how numbers map to actual brightness values is often critical—both before and after the photo has been taken.

There is no one "ideal histogram" which all images should try to mimic;

histograms should be representative of the tonal range in the scene and what the photographer (or you the DIP expert*) wishes to convey.

<http://www.cambridgeincolour.com/tutorials/histograms1.htm>

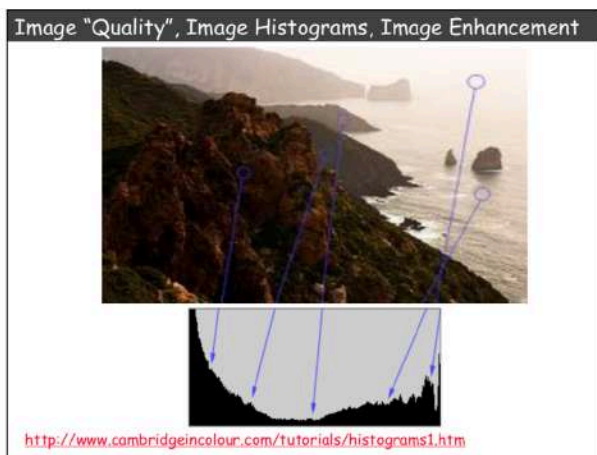
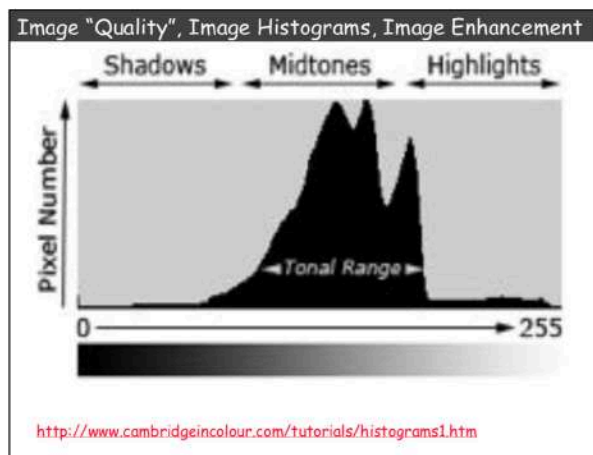


Image "Quality", Image Histograms, Image Enhancement

...most cameras will produce midtone-centric histograms when in an automatic exposure mode,

the distribution of peaks within a histogram also depends on the tonal range of the subject matter.

Images where most of the tones occur in the shadows are called "low key,"

whereas with "high key" images most of the tones are in the highlights.

<http://www.cambridgeincolour.com/tutorials/histograms1.htm>

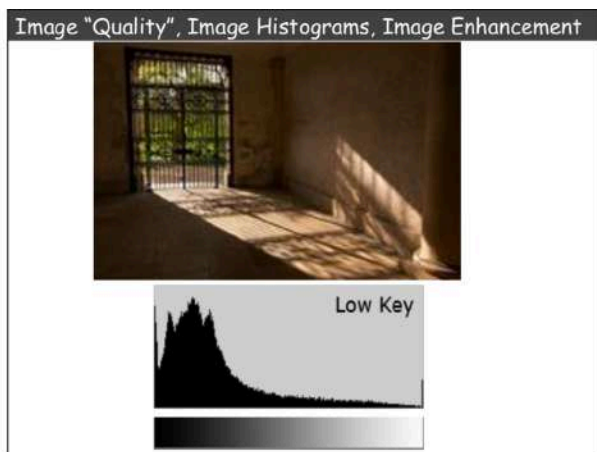
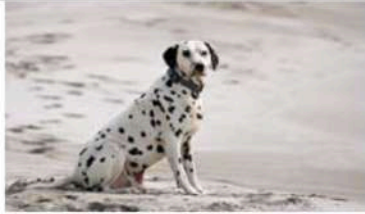


Image "Quality", Image Histograms, Image Enhancement



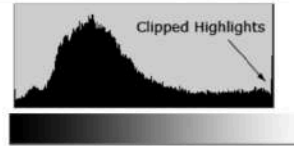
High Key



Image "Quality", Image Histograms, Image Enhancement

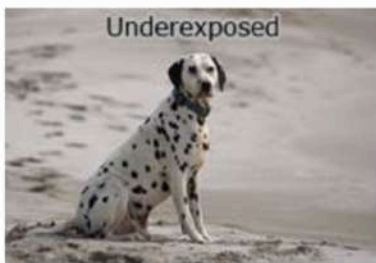


Clipped Highlights



<http://www.cambridgeincolour.com/tutorials/histograms1.htm>

Image "Quality", Image Histograms, Image Enhancement

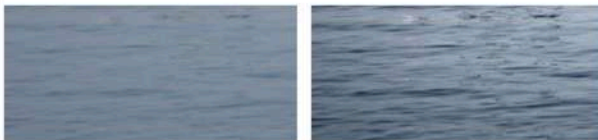


"Saturated" / "Clipped" Image Histograms

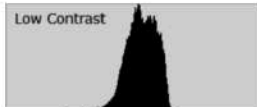


<http://www.cambridgeincolour.com/tutorials/histograms1.htm>

"Contrast" and Image Histograms



Low Contrast



High Contrast



<http://www.cambridgeincolour.com/tutorials/histograms1.htm>

Image "Quality" & Image Histograms

http://media.digitalcameraworld.com/wp-content/uploads/sites/123/2013/06/Photography_histogram_tutorial.jpg



Reviewing images with the histogram

Learn to look at the graph as you assess your shots

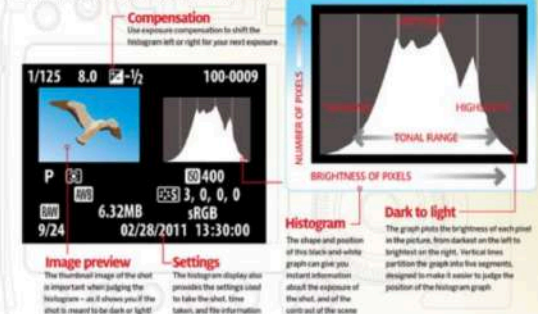


Image "Quality" & Image Histograms

http://media.digitalcameraworld.com/wp-content/uploads/sites/123/2013/06/Photography_histogram_tutorial.jpg



Reviewing images with the histogram

Learn to look at the graph as you assess your shots

Compensation

Use exposure compensation to shift the histogram left or right for your next exposure

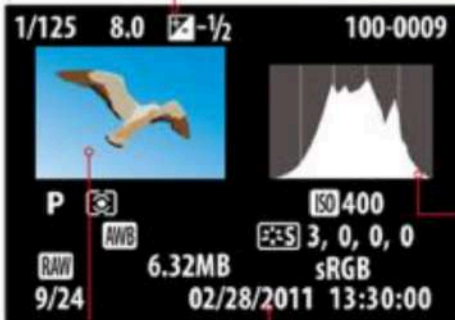
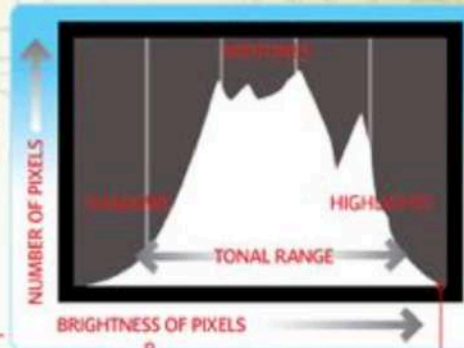


Image preview

The thumbnail image of the shot is important when judging the histograms – as it shows you if the shot is meant to be dark or light!

Settings

The histogram display also provides the settings used to take the shot, time taken, and file information



Histogram

The shape and position of this black-and-white graph can give you instant information about the exposure of the shot, and of the contrast of the scene

Dark to light

The graph plots the brightness of each pixel in the picture, from darkest on the left to brightest on the right. Vertical lines partition the graph into five segments, designed to make it easier to judge the position of the histogram graph

Other histogram shapes

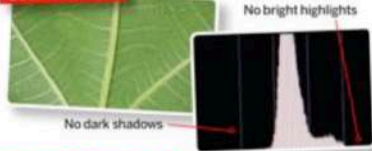
Four graph types that are worth getting to know...

High contrast



Some scenes have a greater tonal range than your SLR can cope with. A gradient filter, or shooting at a different time, can help reduce the contrast. Or just reshoot so highlights aren't clipped.

Low contrast



Some subjects contain no highlights or shadows. Ideally these should be re-exposed so the graph is as far to the right as possible, known as 'exposing to the right'.

White background



In some shots, it is perfectly acceptable for areas to be burnt out, and recorded in pure white. An extreme example of this is when shooting against a white backdrop in a studio.

Black background



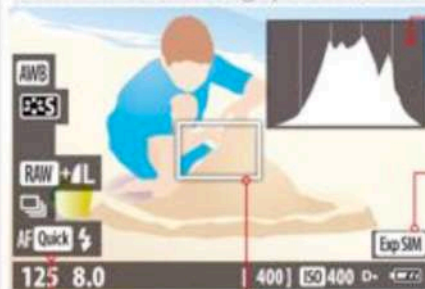
Dark scenes will mean that the graph will peak on the left side. Clipped shadows may not be a problem, if you want some areas of the shot to appear jet black in the image.

http://media.digitalcameraworld.com/wp-content/uploads/sites/123/2013/06/Photography_histogram_tutorial.jpg

Image "Quality", Image Histograms, Image Enhancement

See the histogram as you shoot

Use Live View to see the graph before the shot is taken



Live histogram

In Live View, the histogram is displayed over the image as you frame the picture. As you alter the framing, and adjust the exposure settings, the shape of the histogram will change

Exposure simulation

This menu option is invaluable in most shooting situations, as it means the picture darkens and lightens according to your settings - giving a good pictorial preview of what the shot will look like. Turn it off, however, to aid framing when using flash in low light

Settings

The histogram display also shows settings currently being used by the camera

Magnifying frame

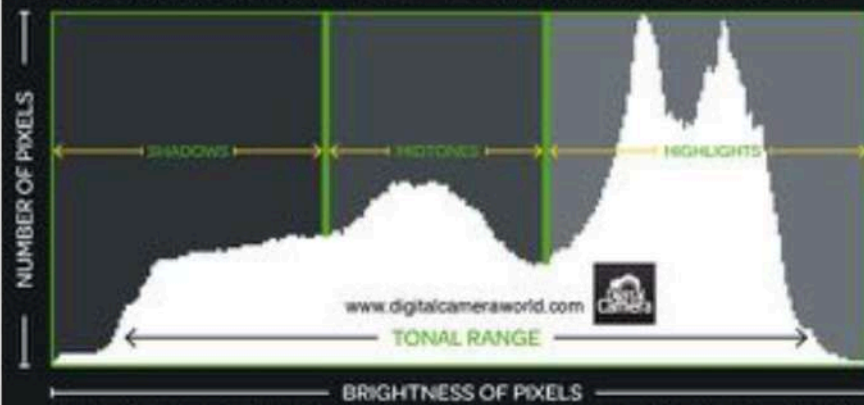
This is the area that will be shown if you press the blue + zoom key on the back of your DSLR. Use the cursor keys to move it around the frame. Once zoomed in, the histogram will temporarily disappear



EXPLAINED HOW TO READ A HISTOGRAM

A camera's histogram is an accurate guide to exposure, as it illustrates the range of tones, or brightness levels, present in an image. You

should review the histogram each time you take a picture, so that you can assess if you need to make any exposure adjustments.



The horizontal axis of the graph represents the brightness level, from darkest on the left to brightest on the right. The vertical axis shows how many pixels in the picture are at that brightness level



The histogram's size and shape gives you an instant guide to the contrast level of this scene. This image contains a full range of tones, including slightly clipped shadows (on the left of the shot) and burnt-out highlights (on the windows)

Luminosity (or Luminance) Histogram

Luminance* histograms are more accurate than RGB histograms at describing the perceived brightness distribution or "luminosity" within an image. Luminosity takes into account the fact that the **human eye is more sensitive to green light than red or blue light**. View the above example again for each color and you will see that the green intensity levels within the image are most representative of the brightness distribution for the full color image. This also reflected by the fact that the luminance histogram also matches the green histogram more than any other color. Luminosity correctly predicts that the following stepped gradient gradually increases in lightness, whereas a simple addition of each RGB value would give the same intensity at each rectangle.

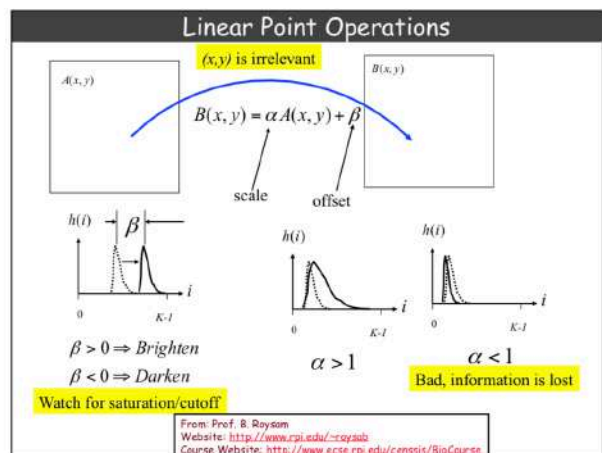
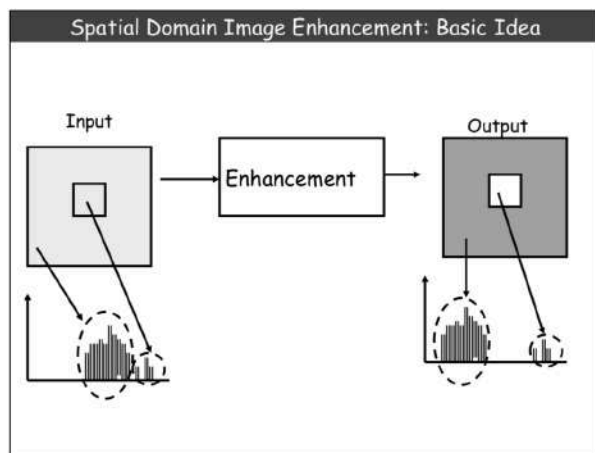
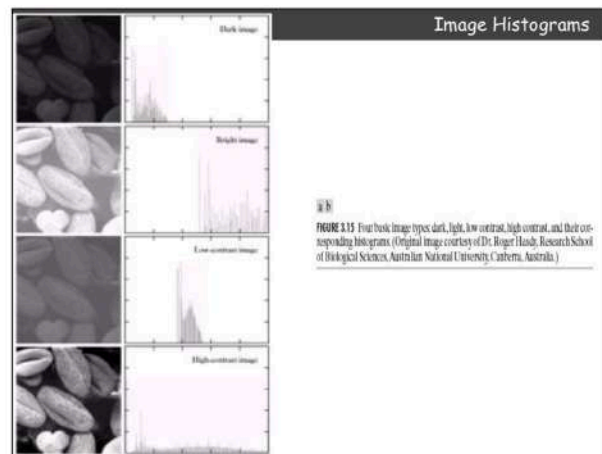
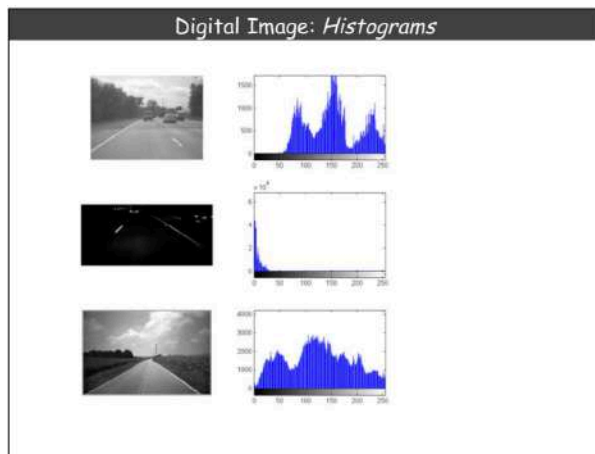
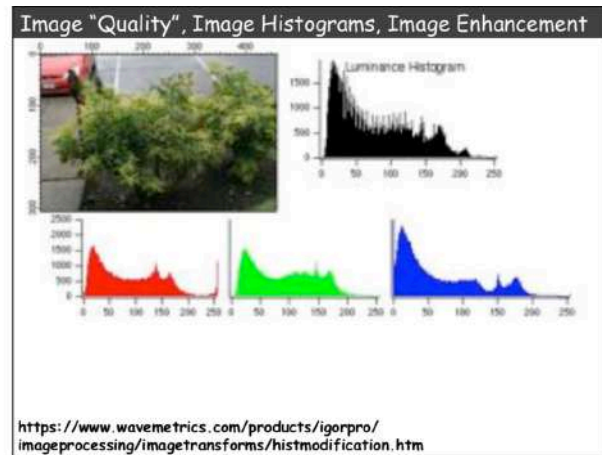
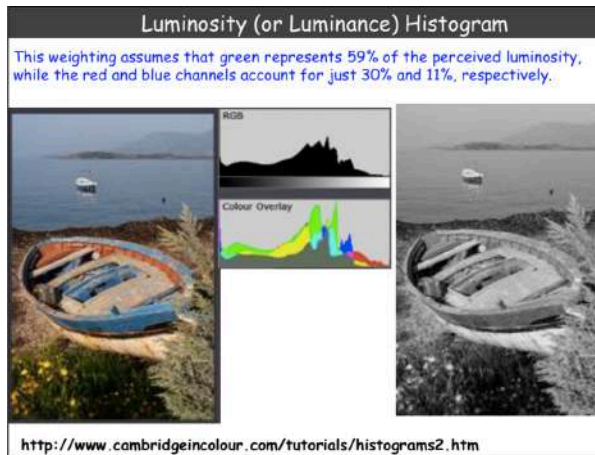
Darkest Lightest



How is a luminance histogram produced? First, each pixel is converted so that it represents a luminosity based on a weighted average of the three colors at that pixel.

This weighting assumes that green represents 59% of the perceived luminosity, while the red and blue channels account for just 30% and 11%, respectively.

<http://www.cambridgeincolour.com/tutorials/histograms2.htm>



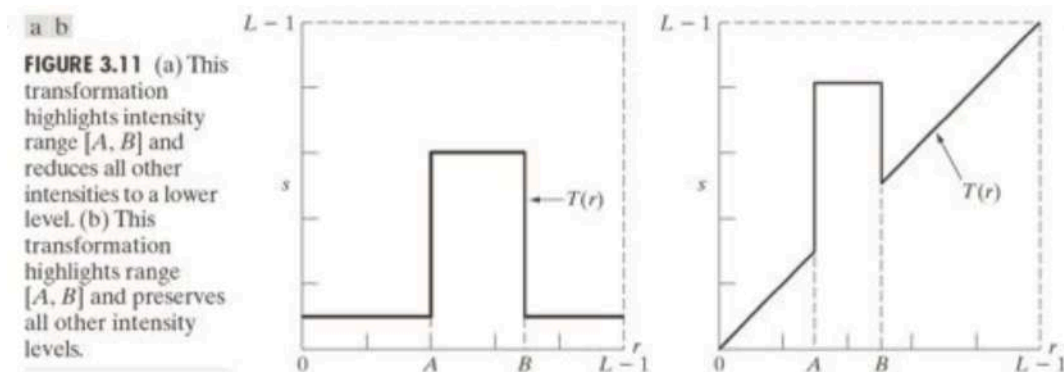
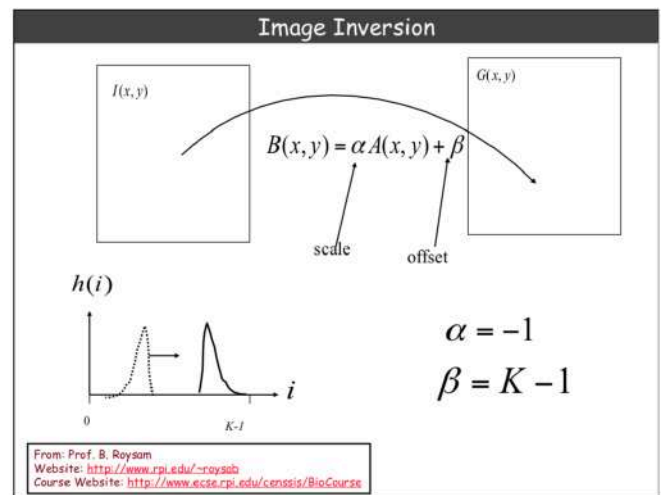
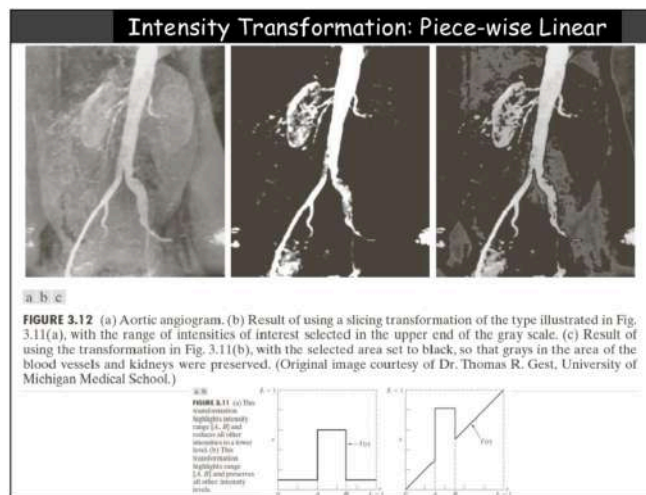
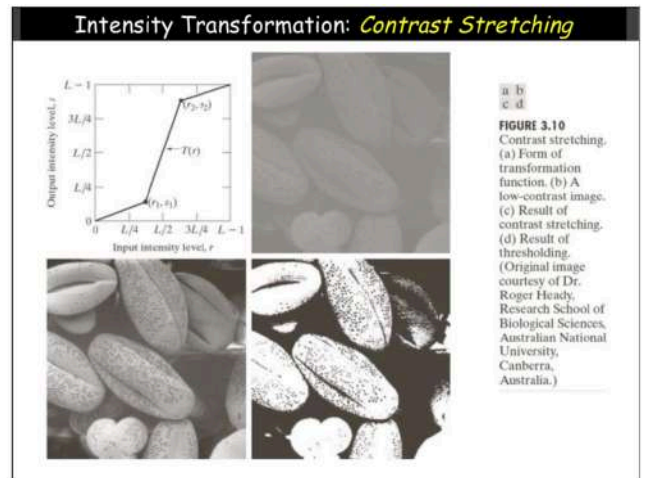
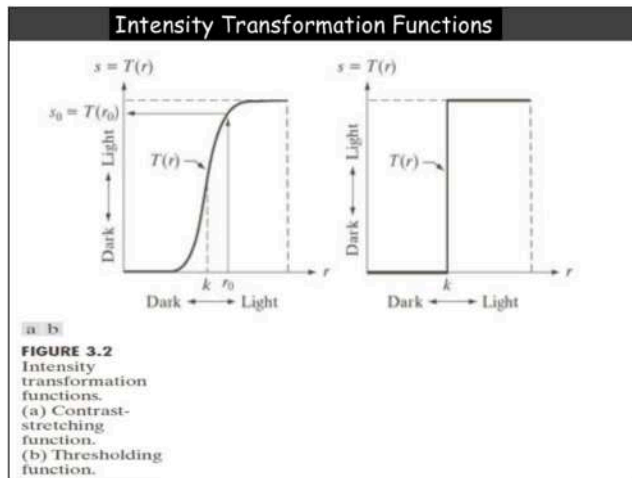
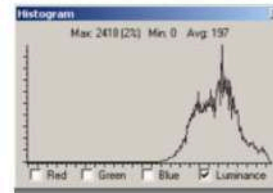
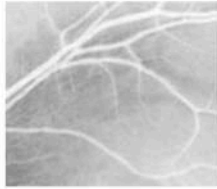
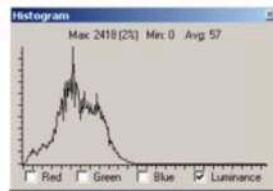
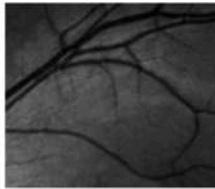


Image Inversion (Negative Image)



Simple Intensity Transformation Function: *Negative*

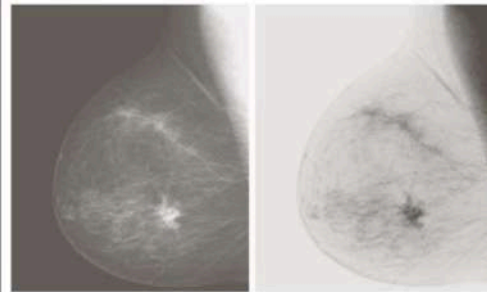


FIGURE 3.4
(a) Original digital mammogram.
(b) Negative image obtained using the negative transformation in Eq. (3.2-1).
(Courtesy of G.E. Medical Systems.)