



Div. Ingeniería de Sistemas y Automática

Universidad Miguel Hernández

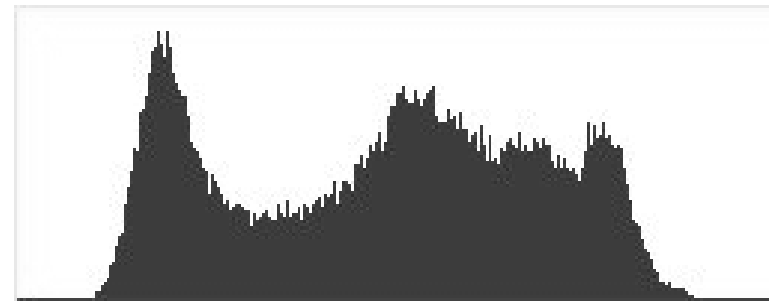
IMAGE FEATURES

TRANSFORMING IMAGES



- Image Features
 - Histogram
 - Brightness
 - Contrast
 - Sharpness
 - Noise
- Image Transformations

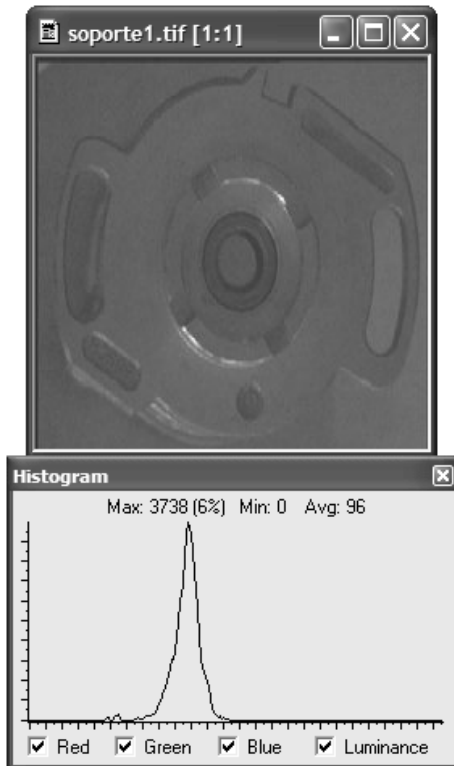
- Image histogram
 - Gray level distribution in an image
 - It can be regarded as a probability distribution function over each gray level in the image.
 - x : Possible intensity range
 - y : Number of pixels with that particular value



$$f[246] = 0$$

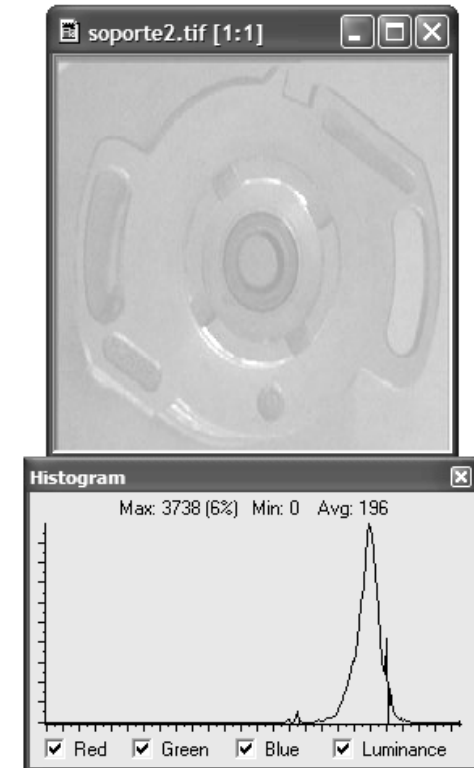
- Image Features
 - ✓ Histogram
 - Brightness
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- Brightness
 - It can be regarded as the mean value of all the pixels in an image



Brightness=56

$$B = \frac{1}{N \cdot M} \sum_{y=0}^{N-1} \sum_{x=0}^{M-1} f(x, y)$$

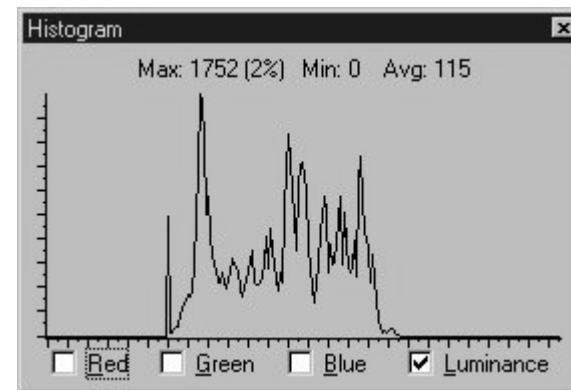
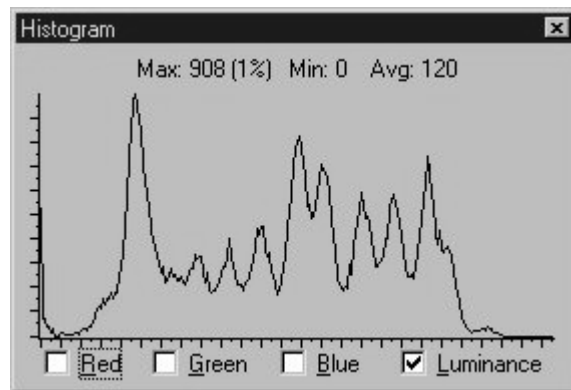


Brightness=156

- Image Features
 - ✓ Histogram
 - ✓ Brightness
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- Contrast
- The contrast in an image is related with the variation of the values along all its pixels.
- Estimation:

$$C = \sqrt{\frac{1}{N \cdot M} \sum_{y=0}^{N-1} \sum_{x=0}^{M-1} (f(x, y) - B)^2}$$



- Image Features
 - ✓ Histogram
 - ✓ Brightness
 - ✓ Contrast
 - Sharpness
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- Sharpness
 - It defines how well are the edges defined in the image.
- Typical: Blurring caused by defocussed images.
- Others: Blurring caused by image transformation algorithms.



- Image Features
 - ✓ Histogram
 - ✓ Brightness
 - ✓ Contrast
 - ✓ Sharpness
 - Noise
- Image Transformations

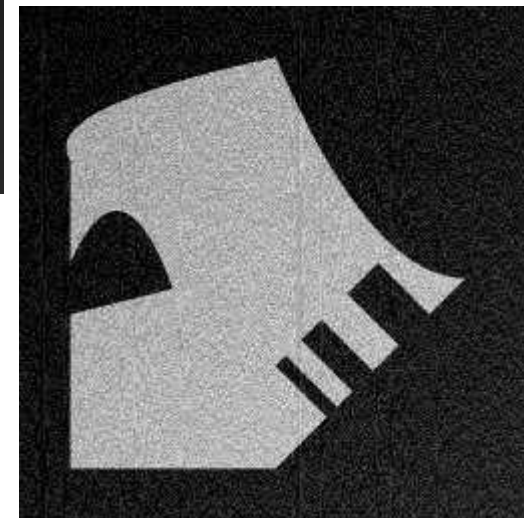
- Noise: Variation in the gray level that does not depend on luminical information from the scene.
 - Correlated: Depends on the position of the pixel that is affected.
 - Uncorrelated: Does not depend on the position.



Correlated noise (E.g. coming from the digitizer)



Noise-free image



Gaussian noise with $\mu=0$ $\sigma=25$

- ✓ Image Features
- Image Transformations

- Example



Original 256 gray level image
Each pixel: 0-255



Inverted = $255 - I(i, j)$

- Example

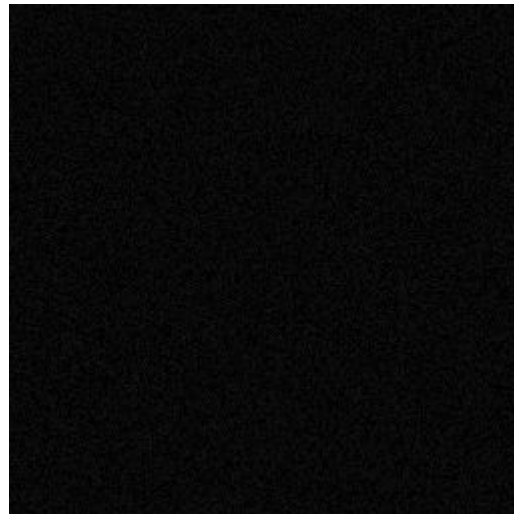
Original



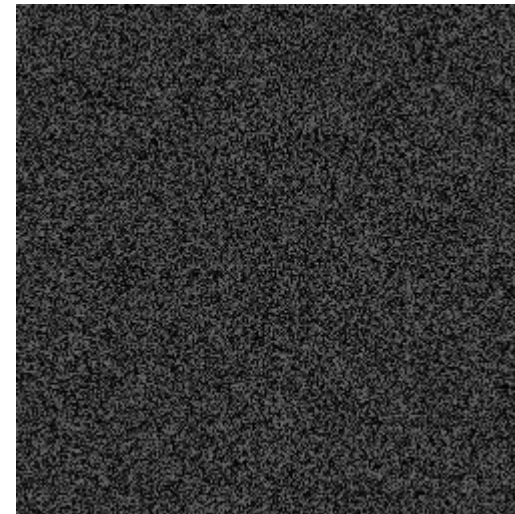
Original
plus
Gaussian
noise



Difference



6*Difference



- Example



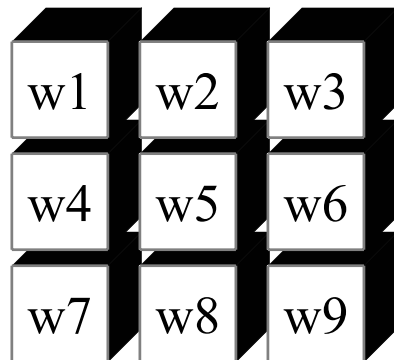
Original



Thresholded
128

- Convolution (very important operation)

$$g(x,y) = w1*f(x-1,y-1)+ w2*f(x,y-1)+ w3*f(x+1,y-1)+ \\ w4*f(x-1,y)+ w5*f(x,y)+ w6*f(x+1,y)+ \\ w7*f(x-1,y+1)+ w8*f(x,y+1)+ w9*f(x+1,y+1)$$



Mask

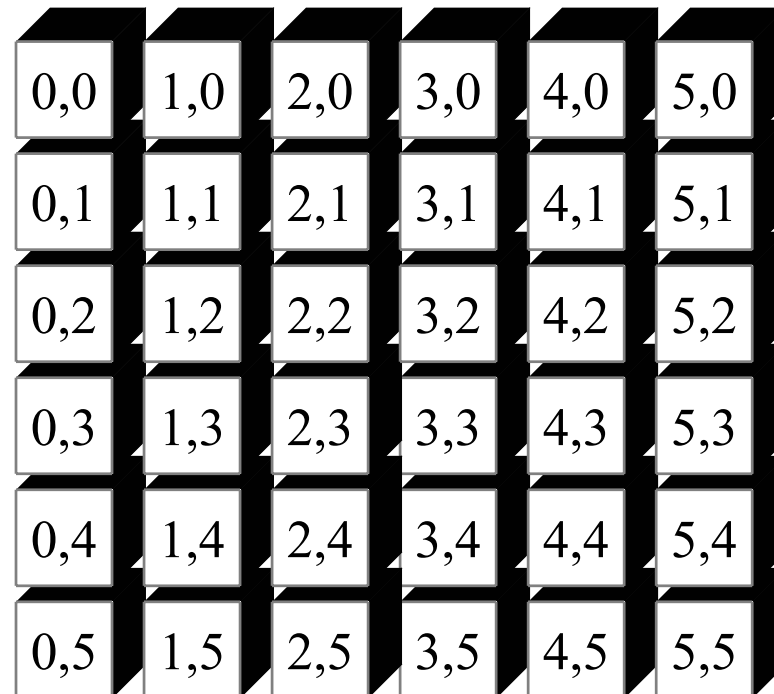


Image (index)

- Convolution

0,0	1,0	2,0	3,0	4,0	5,0
0,1	s1	s2	s3	4,1	5,1
0,2	s4	s5	s6	4,2	5,2
0,3	s7	s8	s9	4,3	5,3
0,4	1,4	2,4	3,4	4,4	5,4
0,5	1,5	2,5	3,5	4,5	5,5

$g(2,2) =$

- $f(1,1)*w1+$
- $f(2,1)*w2+$
- $f(3,1)*w3+$
- $f(1,2)*w4+$
- $f(2,2)*w5+$
- $f(3,2)*w6+$
- $f(1,3)*w7+$
- $f(2,3)*w8+$
- $f(3,3)*w9$

- Convolution, we compute $g(x, y)$ for all the indexes in the image

0,0	1,0	2,0	3,0	4,0	5,0
0,1	1,1	s1	s2	s3	5,1
0,2	1,2	s4	s5	s6	5,2
0,3	1,3	s7	s8	s9	5,3
0,4	1,4	2,4	3,4	4,4	5,4
0,5	1,5	2,5	3,5	4,5	5,5

$$g(3,2) =$$

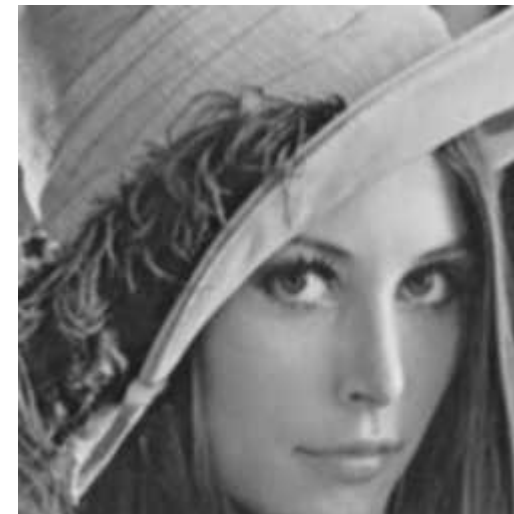
$$\begin{aligned}
 & f(2,1)*w1+ \\
 & f(3,1)*w2+ \\
 & f(4,1)*w3+ \\
 & f(2,2)*w4+ \\
 & f(3,2)*w5+ \\
 & f(4,2)*w6+ \\
 & f(2,3)*w7+ \\
 & f(3,3)*w8+ \\
 & f(4,3)*w9
 \end{aligned}$$

- We can achieve different results by changing the values in the mask



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1	1	1
1	1	1
1	1	1



-1	0	1
-1	0	1
-1	0	1



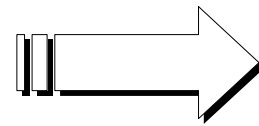
- Non-linear (statistical)



Original +
Random noise



Median Filter



Warping

- Morphing

