تجزیه وتحلیل داده ها در نساجی

پردازش تصویر

دکتر پدرام پیوندی

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انواع تصویر

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انواع تصویر

- Intensity Images (Gray- Scale):

به تصویری گفته می‌شود که تنها دارای مقادیر روشنایی است و خصوصیات رنگ مانند فام و خلوص را ندارد. در Matlab این تصاویر توسط ماتریس‌های دوبعدی تعریف می‌شوند به‌طوری‌که مقدار هر عنصر از این ماتریس معرف میزان روشنایی پیکسل متناظرش در تصویر مربوطه است. دامنهٔ تغییرات عناصر این ماتریس ممکن است بین ۰ تا ۱ و یا بین ۰ تا ۲۵۵ تغییر کند.

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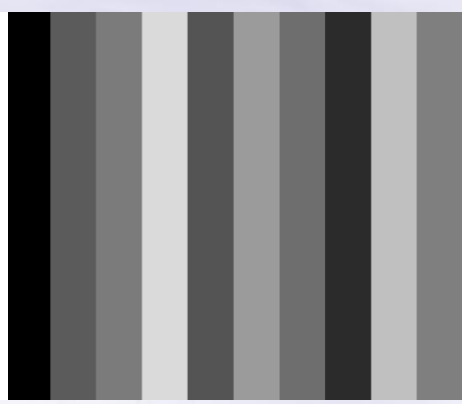
Intensity Images - Sample

```
Im_Gray =

   0   91  123  218   84  155  110   43  192  127
   0   91  123  218   84  155  110   43  192  127
   0   91  123  218   84  155  110   43  192  127
   0   91  123  218   84  155  110   43  192  127
   0   91  123  218   84  155  110   43  192  127
   0   91  123  218   84  155  110   43  192  127
   0   91  123  218   84  155  110   43  192  127
   0   91  123  218   84  155  110   43  192  127
   0   91  123  218   84  155  110   43  192  127
   0   91  123  218   84  155  110   43  192  127
```



4

- Binary Images:

یک تصویر باینری به تصویری گفته می‌شود که هر پیکسل از آن تنها بتواند دارای یکی از دو مقدار ممکن (معمولا ۰ و ۱) باشد، یعنی هر پیکسل می‌تواند یکی از دو رنگ سیاه (برای پس‌زمینه) و سفید (برای نمایش لبه‌ها) را داشته باشد. از آن‌جاکه برای ذخیرۀ هر پیکسل تنها به یک بیت نیاز داریم، این‌گونه تصاویر به‌راحتی ذخیره می‌شوند و مقادیر آنها می‌تواند، (۰ و ۱) و یا (۰و ۲۵۵) باشد.

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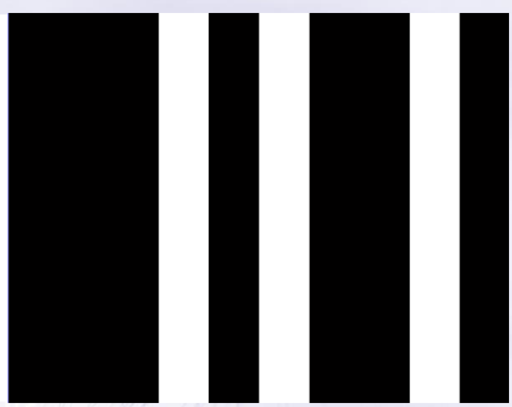
Binary Images – Sample

```
Im_BW =

  0  0  0  1  0  1  0  0  1  0
  0  0  0  1  0  1  0  0  1  0
  0  0  0  1  0  1  0  0  1  0
  0  0  0  1  0  1  0  0  1  0
  0  0  0  1  0  1  0  0  1  0
  0  0  0  1  0  1  0  0  1  0
  0  0  0  1  0  1  0  0  1  0
  0  0  0  1  0  1  0  0  1  0
  0  0  0  1  0  1  0  0  1  0
  0  0  0  1  0  1  0  0  1  0
```



6

- RGB Images (True color):

یک تصویر RGB به تصویری گفته می‌شود که به ازای هر پیکسل از آن سه عدد بین ۰ تا ۲۵۵ در حافظه کامپیوتر ذخیره می‌شود. این اعداد معرف شدت هر یک از رنگ‌های قرمز، سبز و آبی است. مثلاً برای یک پیکسل سفید سه عدد (۲۵۵،۲۵۵،۲۵۵) و برای یک پیکسل سبز سه عدد (۰،۲۵۵،۰) به ترتیب معرف شدت رنگ‌های قرمز، سبز و آبی است. بنابراین برای هر نقطه از تصویر بیش از ۱۶ میلیون (۲۵۶*۲۵۶*۲۵۶) حالت رنگی مختلف امکان‌پذیر خواهد بود. واضح است که یک تصویر RGB سه برابر یک تصویر شدتی هم‌اندازه با آن، حافظه کامپیوتر را اشغال خواهد کرد و به همان نسبت هم به زمان پردازش بیشتری نیاز دارد.

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```
val(:,:,1) =

     0   237    34   255    63   255   163   136   181   127
     0   237    34   255    63   255   163   136   181   127
     0   237    34   255    63   255   163   136   181   127
     0   237    34   255    63   255   163   136   181   127
     0   237    34   255    63   255   163   136   181   127
```

```
val(:,:,2) =

     0    28   177   242    72   127    73     0   230   127
     0    28   177   242    72   127    73     0   230   127
     0    28   177   242    72   127    73     0   230   127
     0    28   177   242    72   127    73     0   230   127
     0    28   177   242    72   127    73     0   230   127
```

```
val(:,:,3) =

     0    36    76     0   204    39   164    21    29   127
     0    36    76     0   204    39   164    21    29   127
     0    36    76     0   204    39   164    21    29   127
     0    36    76     0   204    39   164    21    29   127
     0    36    76     0   204    39   164    21    29   127
     0    36    76     0   204    39   164    21    29   127
     0    36    76     0   204    39   164    21    29   127
     0    36    76     0   204    39   164    21    29   127
     0    36    76     0   204    39   164    21    29   127
     0    36    76     0   204    39   164    21    29   127
```

RGB Images – Sample

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R: 0 G: 0 B: 0	R:237 G: 28 B: 36	R: 34 G:177 B: 76	R:255 G:242 B: 0	R: 63 G: 72 B:204	R:255 G:127 B: 39	R:163 G: 73 B:164	R:136 G: 0 B: 21	R:181 G:230 B: 29	R:127 G:127 B:127
R: 0 G: 0 B: 0	R:237 G: 28 B: 36	R: 34 G:177 B: 76	R:255 G:242 B: 0	R: 63 G: 72 B:204	R:255 G:127 B: 39	R:163 G: 73 B:164	R:136 G: 0 B: 21	R:181 G:230 B: 29	R:127 G:127 B:127
R: 0 G: 0 B: 0	R:237 G: 28 B: 36	R: 34 G:177 B: 76	R:255 G:242 B: 0	R: 63 G: 72 B:204	R:255 G:127 B: 39	R:163 G: 73 B:164	R:136 G: 0 B: 21	R:181 G:230 B: 29	R:127 G:127 B:127
R: 0 G: 0 B: 0	R:237 G: 28 B: 36	R: 34 G:177 B: 76	R:255 G:242 B: 0	R: 63 G: 72 B:204	R:255 G:127 B: 39	R:163 G: 73 B:164	R:136 G: 0 B: 21	R:181 G:230 B: 29	R:127 G:127 B:127
R: 0 G: 0 B: 0	R:237 G: 28 B: 36	R: 34 G:177 B: 76	R:255 G:242 B: 0	R: 63 G: 72 B:204	R:255 G:127 B: 39	R:163 G: 73 B:164	R:136 G: 0 B: 21	R:181 G:230 B: 29	R:127 G:127 B:127
R: 0 G: 0 B: 0	R:237 G: 28 B: 36	R: 34 G:177 B: 76	R:255 G:242 B: 0	R: 63 G: 72 B:204	R:255 G:127 B: 39	R:163 G: 73 B:164	R:136 G: 0 B: 21	R:181 G:230 B: 29	R:127 G:127 B:127
R: 0 G: 0 B: 0	R:237 G: 28 B: 36	R: 34 G:177 B: 76	R:255 G:242 B: 0	R: 63 G: 72 B:204	R:255 G:127 B: 39	R:163 G: 73 B:164	R:136 G: 0 B: 21	R:181 G:230 B: 29	R:127 G:127 B:127
R: 0 G: 0 B: 0	R:237 G: 28 B: 36	R: 34 G:177 B: 76	R:255 G:242 B: 0	R: 63 G: 72 B:204	R:255 G:127 B: 39	R:163 G: 73 B:164	R:136 G: 0 B: 21	R:181 G:230 B: 29	R:127 G:127 B:127
R: 0 G: 0 B: 0	R:237 G: 28 B: 36	R: 34 G:177 B: 76	R:255 G:242 B: 0	R: 63 G: 72 B:204	R:255 G:127 B: 39	R:163 G: 73 B:164	R:136 G: 0 B: 21	R:181 G:230 B: 29	R:127 G:127 B:127
R: 0 G: 0 B: 0	R:237 G: 28 B: 36	R: 34 G:177 B: 76	R:255 G:242 B: 0	R: 63 G: 72 B:204	R:255 G:127 B: 39	R:163 G: 73 B:164	R:136 G: 0 B: 21	R:181 G:230 B: 29	R:127 G:127 B:127

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- Indexed Images

این تصاویر توسط دو ماتریس زیر مشخص می‌شوند:

1. ماتریس اندیس: ابعاد این ماتریس برابر با ابعاد تصویر برحسب پیکسل است. مقادیر این ماتریس معمولا بین ۱ تا ۲۵۶ تغییر می‌کند و مقدار هر درایه از این ماتریس معرف شمارهٔ سطری از ماتریس نقشه‌رنگ است.
2. ماتریس نقشه‌رنگ: این ماتریس دارای ۳ ستون است و هر سطر ازآن معرف یکی از رنگ‌های موجود در تصویر است. به‌طوری‌که عنصر اول هر سطر معرف قرمز، عنصر دوم معرف سبز و عنصر سوم معرف آبی است.

یک تصویر اندیس‌شده بسته به مقادیر ماتریس نقشه‌رنگ، ممکن است رنگی یا Gray- Scale باشد.

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Indexed Images – Sample

Map

0	0	0
0.9294	0.1098	0.1412
0.1333	0.6941	0.2980
0.7098	0.9020	0.1137
0.2471	0.2824	0.8000
0.4980	0.4980	0.4980
0.5333	0	0.0824
1.0000	0.4980	0.1529
1.0000	0.9490	0
0.6392	0.2863	0.6431

Index

0	1	2	8	4	7	9	6	3	5
0	1	2	8	4	7	9	6	3	5
0	1	2	8	4	7	9	6	3	5
0	1	2	8	4	7	9	6	3	5
0	1	2	8	4	7	9	6	3	5
0	1	2	8	4	7	9	6	3	5
0	1	2	8	4	7	9	6	3	5
0	1	2	8	4	7	9	6	3	5
0	1	2	8	4	7	9	6	3	5
0	1	2	8	4	7	9	6	3	5

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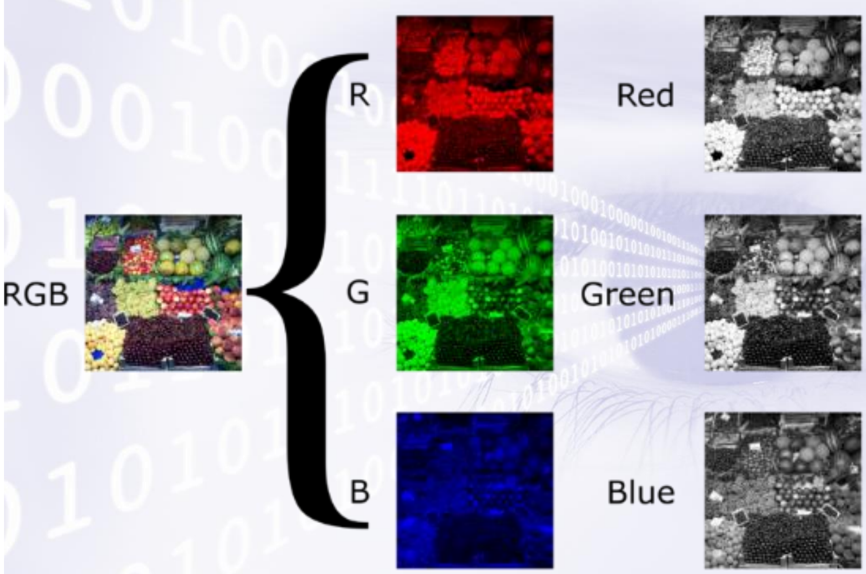
تبدیل تصویر رنگی به خاکستری



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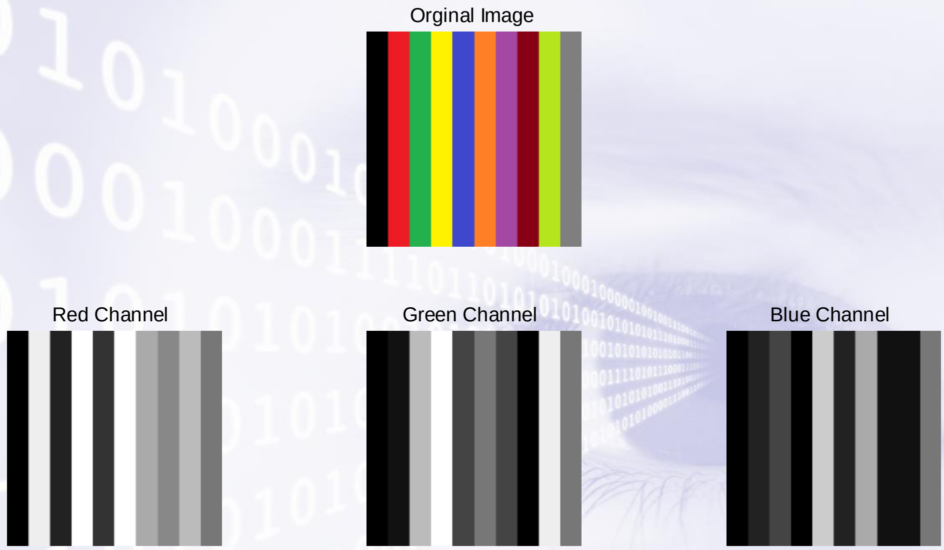

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تبدیل تصویر رنگی به خاکستری

$$Y' = 0.299R' + 0.587G' + 0.114B'$$

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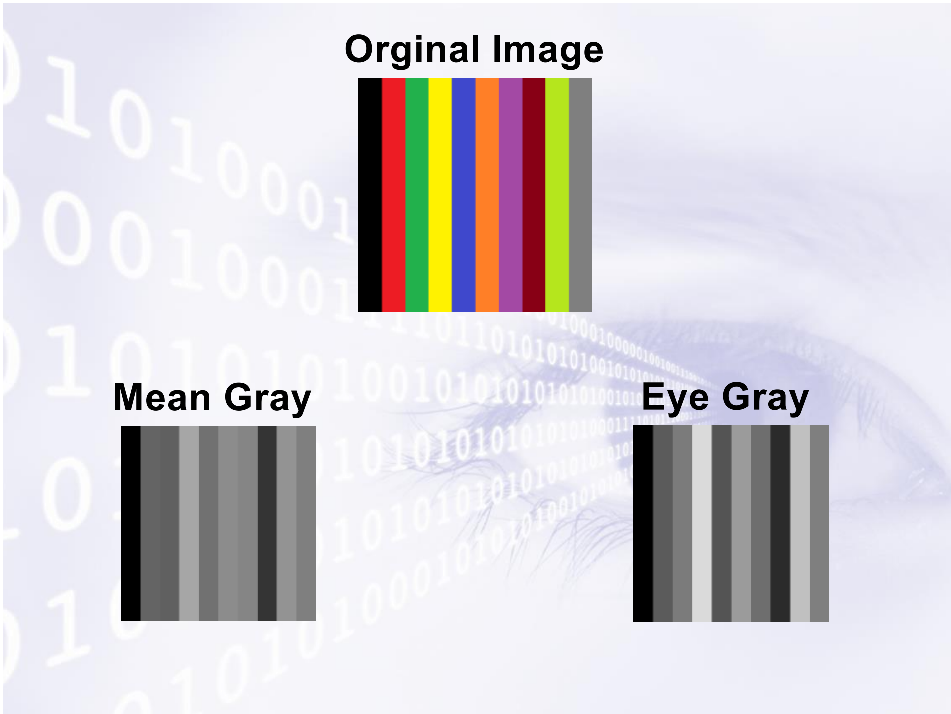

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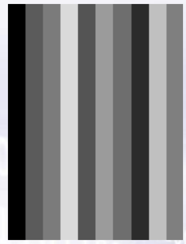
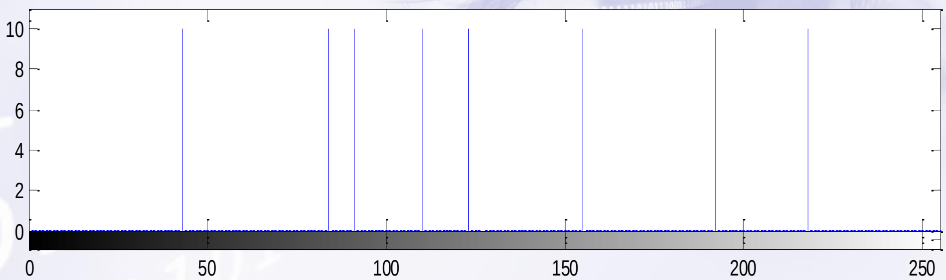
Im_Gray =

0	91	123	218	84	155	110	43	192	127
0	91	123	218	84	155	110	43	192	127
0	91	123	218	84	155	110	43	192	127
0	91	123	218	84	155	110	43	192	127
0	91	123	218	84	155	110	43	192	127
0	91	123	218	84	155	110	43	192	127
0	91	123	218	84	155	110	43	192	127
0	91	123	218	84	155	110	43	192	127
0	91	123	218	84	155	110	43	192	127
0	91	123	218	84	155	110	43	192	127

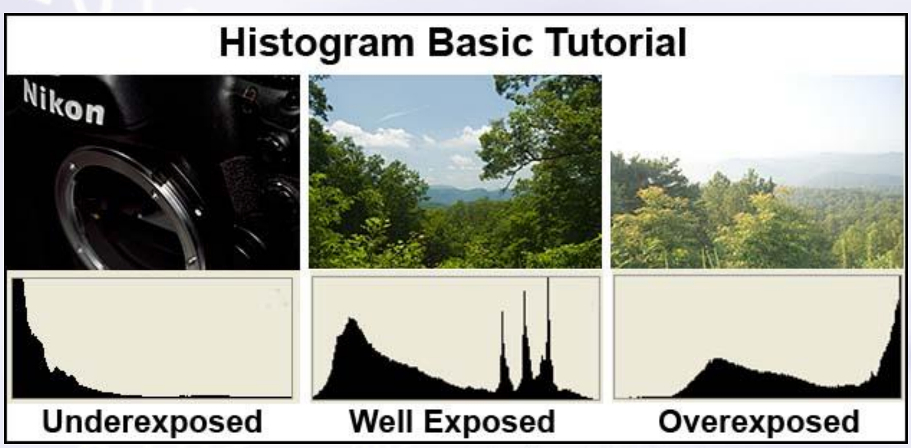
Image



Histogram



17



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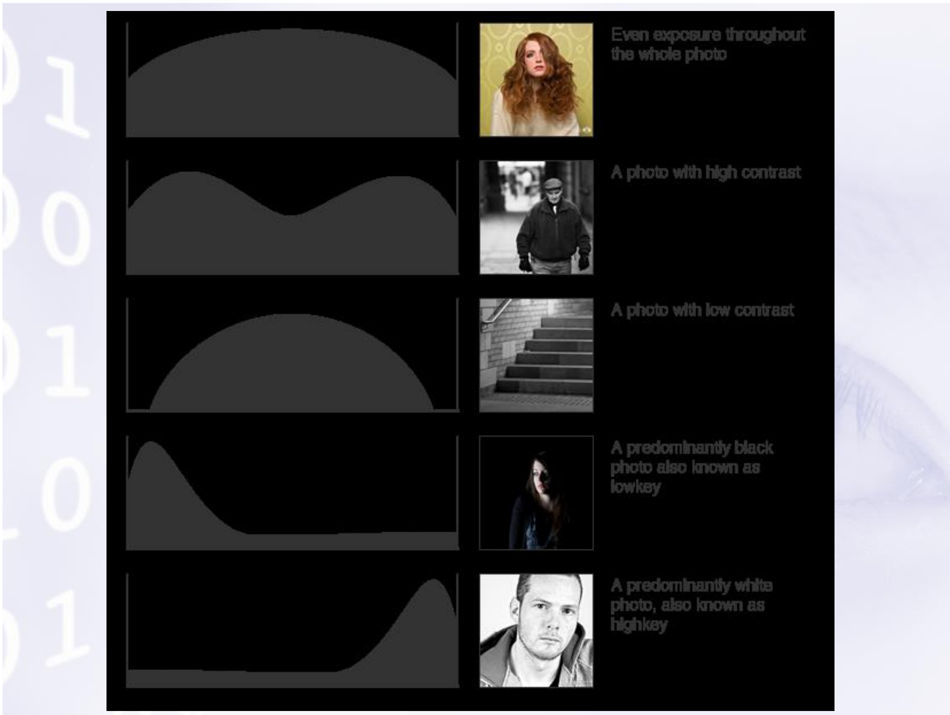
Even exposure throughout the whole photo
A photo with high contrast
A photo with low contrast
A predominantly black photo also known as lowkey
A predominantly white photo, also known as highkey

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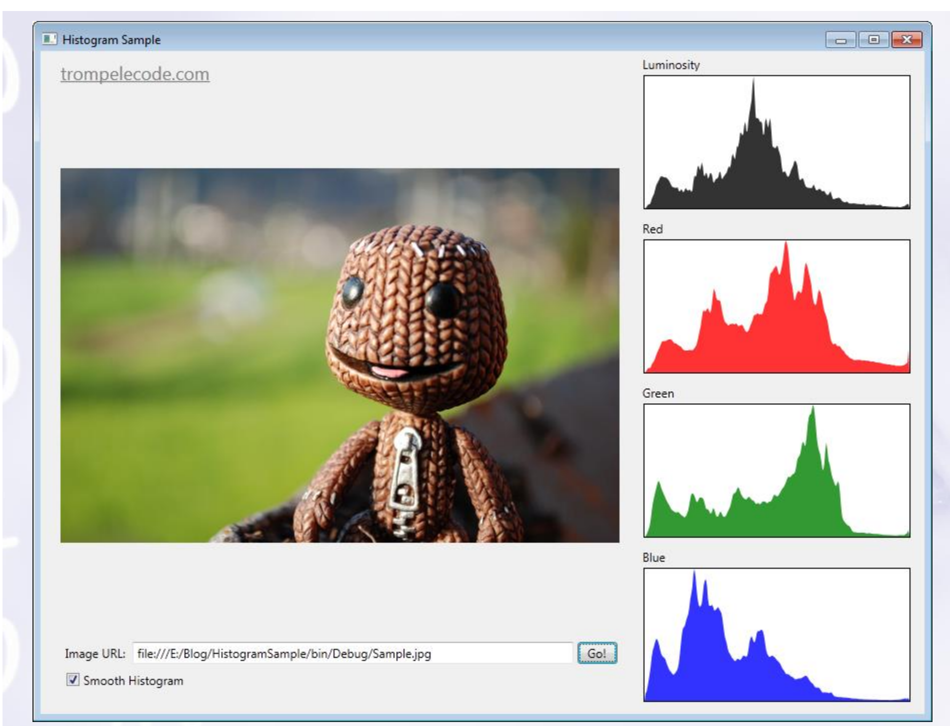
Histogram Sample
trompelecode.com
Luminosity
Red
Green
Blue
Image URL:
file:///E:/Blog/HistogramSample/bin/Debug/Sample.jpg
Go!
Smooth Histogram

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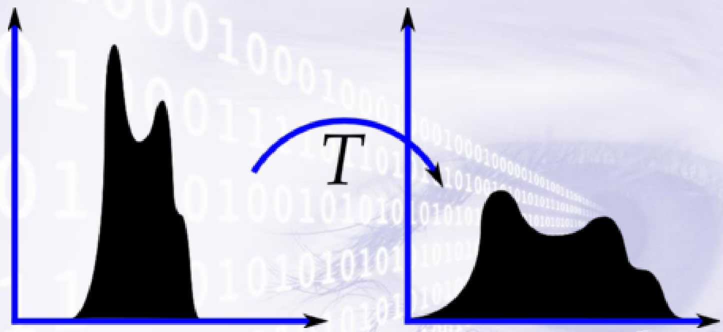
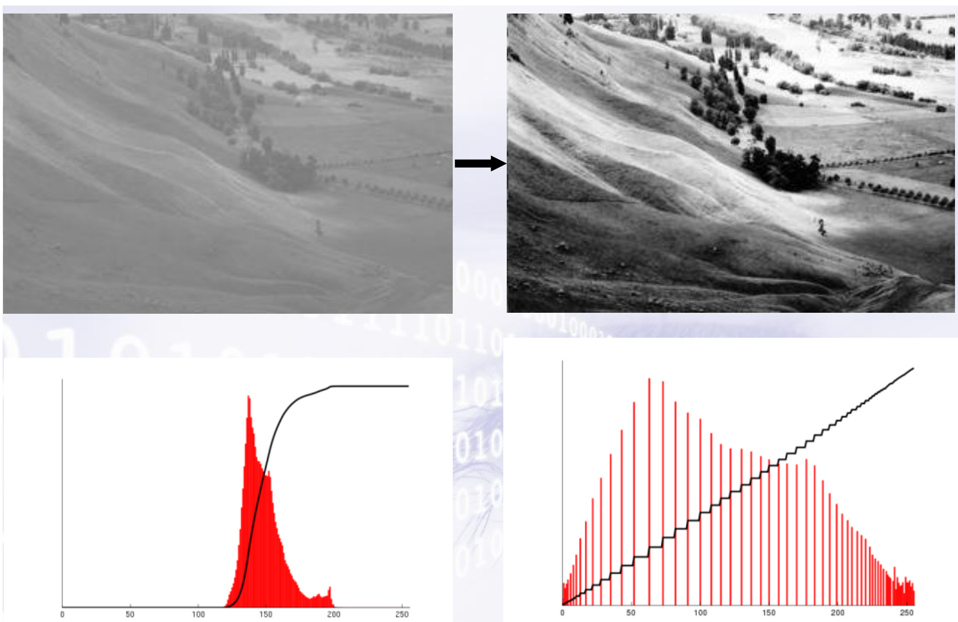
تنظیم هیستوگرام



21



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$$\begin{bmatrix} 52 & 55 & 61 & 66 & 70 & 61 & 64 & 73 \\ 63 & 59 & 55 & 90 & 109 & 85 & 69 & 72 \\ 62 & 59 & 68 & 113 & 144 & 104 & 66 & 73 \\ 63 & 58 & 71 & 122 & 154 & 106 & 70 & 69 \\ 67 & 61 & 68 & 104 & 126 & 88 & 68 & 70 \\ 79 & 65 & 60 & 70 & 77 & 68 & 58 & 75 \\ 85 & 71 & 64 & 59 & 55 & 61 & 65 & 83 \\ 87 & 79 & 69 & 68 & 65 & 76 & 78 & 94 \end{bmatrix}$$

Value	Count	Value	Count	Value	Count	Value	Count	Value	Count
52	1	64	2	72	1	85	2	113	1
55	3	65	3	73	2	87	1	122	1
58	2	66	2	75	1	88	1	126	1
59	3	67	1	76	1	90	1	144	1
60	1	68	5	77	1	94	1	154	1
61	4	69	3	78	1	104	2		
62	1	70	4	79	2	106	1		
63	2	71	2	83	1	109	1		

Value	cdf	cdf, scaled
52	1	0
55	4	12
58	6	20
59	9	32
60	10	36
61	14	53
62	15	57
63	17	65
64	19	73
65	22	85
66	24	93
67	25	97
68	30	117
69	33	130
70	37	146
71	39	154
72	40	158
73	42	166
75	43	170
76	44	174
77	45	178
78	46	182
79	48	190
83	49	194
85	51	202
87	52	206
88	53	210
90	54	215
94	55	219
104	57	227
106	58	231
109	59	235
113	60	239
122	61	243
126	62	247
144	63	251
154	64	255

$$\begin{bmatrix} 0 & 12 & 53 & 93 & 146 & 53 & 73 & 166 \\ 65 & 32 & 12 & 215 & 235 & 202 & 130 & 158 \\ 57 & 32 & 117 & 239 & 251 & 227 & 93 & 166 \\ 65 & 20 & 154 & 243 & 255 & 231 & 146 & 130 \\ 97 & 53 & 117 & 227 & 247 & 210 & 117 & 146 \\ 190 & 85 & 36 & 146 & 178 & 117 & 20 & 170 \\ 202 & 154 & 73 & 32 & 12 & 53 & 85 & 194 \\ 206 & 190 & 130 & 117 & 85 & 174 & 182 & 219 \end{bmatrix}$$

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This cdf shows that the minimum value in the subimage is 52 and the maximum value is 154. The cdf of 64 for value 154 coincides with the number of pixels in the image. The cdf must be normalized to $[0, 255]$. The general histogram equalization formula is:

$$h(v) = \mathrm{round}\left(\frac{cdf(v) - cdf_{min}}{(M \times N) - cdf_{min}} \times (L-1)\right)$$

where cdf_{min} is the minimum non-zero value of the cumulative distribution function (in this case 1), M × N gives the image's number of pixels (for the example above 64, where M is width and N the height) and L is the number of grey levels used (in most cases, like this one, 256).

Note that to scale values in the original data that are above 0 to the range 1 to L-1, inclusive, the above equation would instead be:

$$h(v) = \mathrm{round}\left(\frac{cdf(v) - cdf_{min}}{(M \times N) - cdf_{min}} \times (L-2)\right) + 1$$

where cdf(v) > 0. Scaling from 1 to 255 preserves the non-zero-ness of the minimum value.

The equalization formula for the example scaling data from 0 to 255, inclusive, is:

$$h(v) = \mathrm{round}\left(\frac{cdf(v) - 1}{63} \times 255\right)$$

For example, the cdf of 78 is 46. (The value of 78 is used in the bottom row of the 7th column.) The normalized value becomes

$$h(78) = \mathrm{round}\left(\frac{46-1}{63} \times 255\right) = \mathrm{round}(0.714286 \times 255) = 182$$

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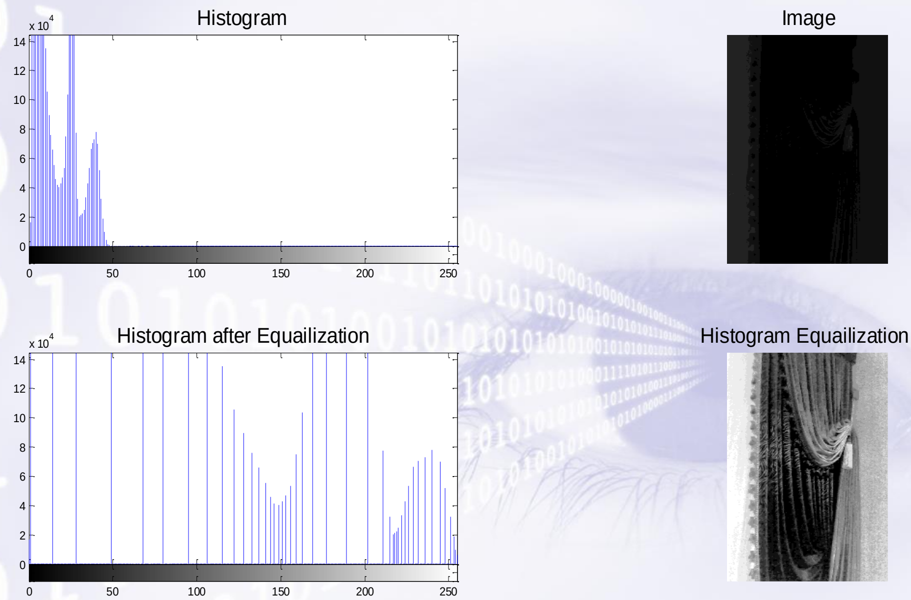

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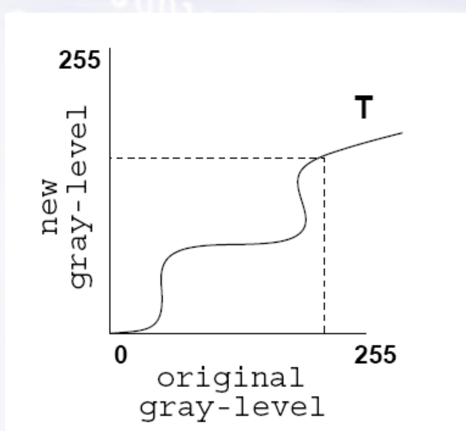
Point Processing Transformations

- Convert a given pixel value to a new pixel value based on some predefined function.



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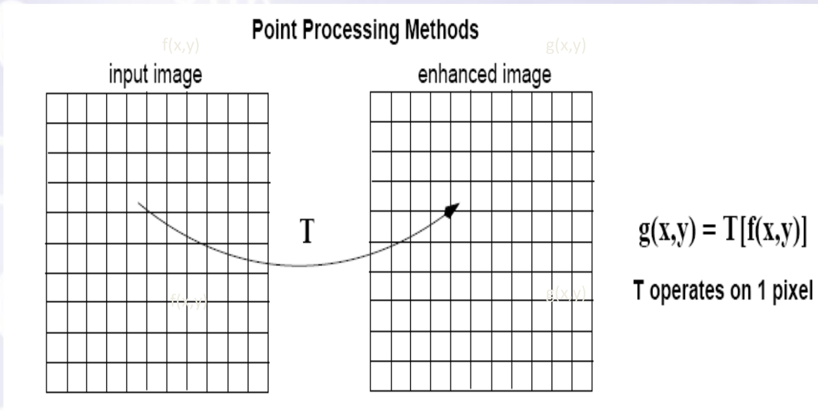
Spatial Domain Methods



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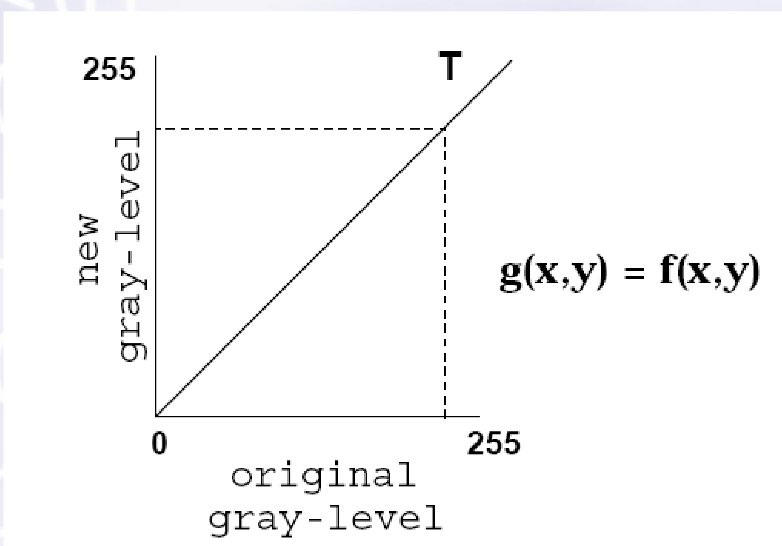
Identity Transformation



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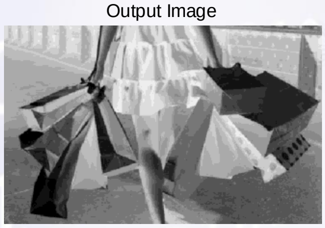
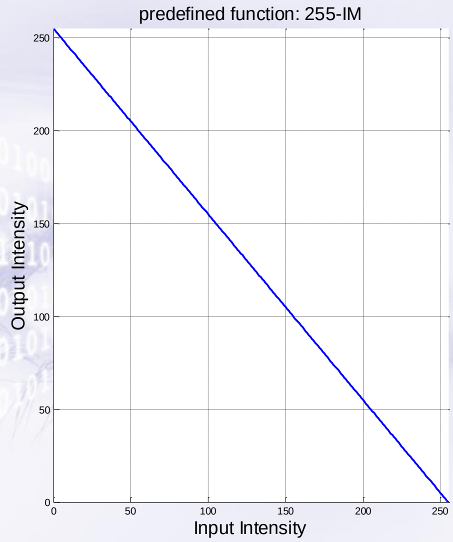
Negative Image

Input Image

Output Image





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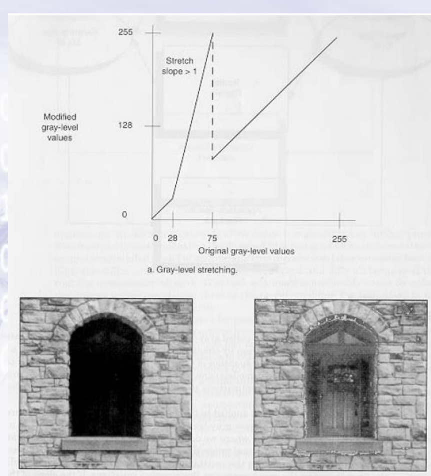
Contrast Stretching/Compression

- Stretch gray-level ranges where we desire more information (slope > 1).
- Compress gray-level ranges that are of little interest (0 < slope < 1).



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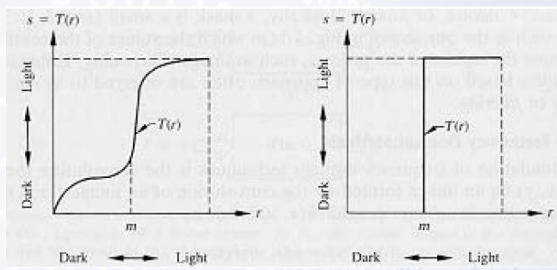
Thresholding

- Special case of contrast compression



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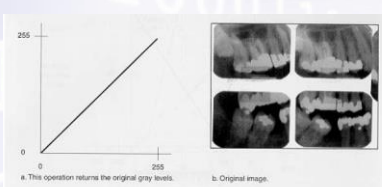
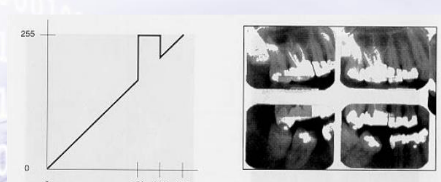
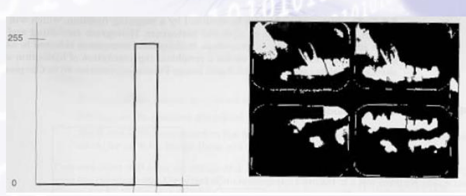
Intensity Level Slicing

- Highlight specific ranges of gray-levels only.







Same as double thresholding!

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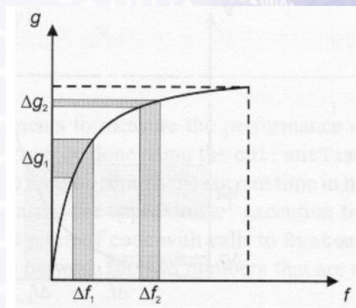
Logarithmic transformation

- Enhance details in the darker regions of an image at the expense of detail in brighter regions.



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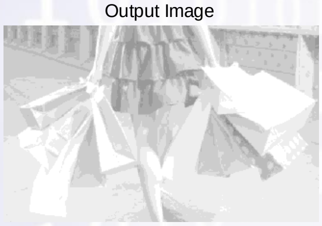
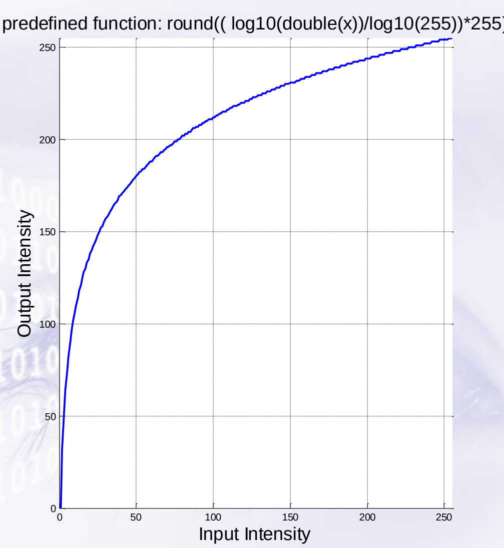
Input Image

Output Image





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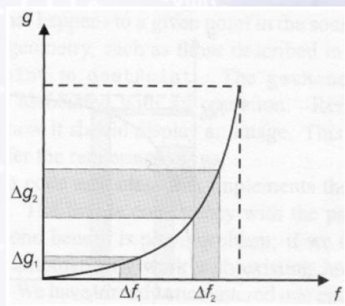
Exponential transformation

- Reverse effect of that obtained using logarithmic mapping.



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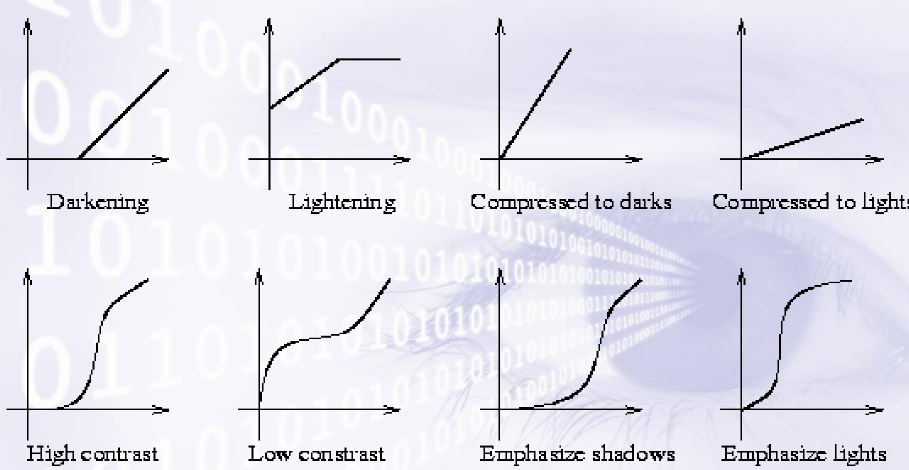
تنظیم هیستوگرام



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Addition

- Useful for combining information between two images

$0 <= \alpha <= 1$

$$O(r,c) = \alpha I_1(r,c) + (1-\alpha) I_2(r,c)$$

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Image1

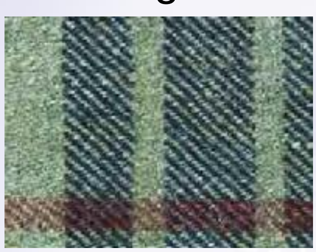

Image sumation α =0.7

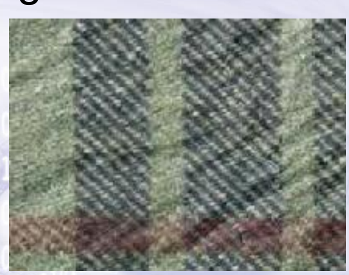

Image2

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Geometric Transformations

Transformation Name	Affine Matrix, T	Coordinate Equations	Example
Identity	$\begin{bmatrix}1&0&0\\0&1&0\\0&0&1\end{bmatrix}$	$x = v$ $y = w$	
Scaling	$\begin{bmatrix}c_x&0&0\\0&c_y&0\\0&0&1\end{bmatrix}$	$x = c_x v$ $y = c_y w$	
Rotation	$\begin{bmatrix}\cos\theta&\sin\theta&0\\-\sin\theta&\cos\theta&0\\0&0&1\end{bmatrix}$	$x = v\cos\theta - w\sin\theta$ $y = v\cos\theta + w\sin\theta$	
Translation	$\begin{bmatrix}1&0&0\\0&1&0\\t_x&t_y&1\end{bmatrix}$	$x = v + t_x$ $y = w + t_y$	
Shear (vertical)	$\begin{bmatrix}1&0&0\\s_v&1&0\\0&0&1\end{bmatrix}$	$x = v + s_v w$ $y = w$	
Shear (horizontal)	$\begin{bmatrix}1&s_h&0\\0&1&0\\0&0&1\end{bmatrix}$	$x = v$ $y = s_h v + w$	

affine transformation

$$[x\ y\ 1] = [v\ w\ 1]\begin{bmatrix}t_{11}&t_{12}&0\\t_{21}&t_{22}&0\\t_{31}&t_{32}&1\end{bmatrix}$$

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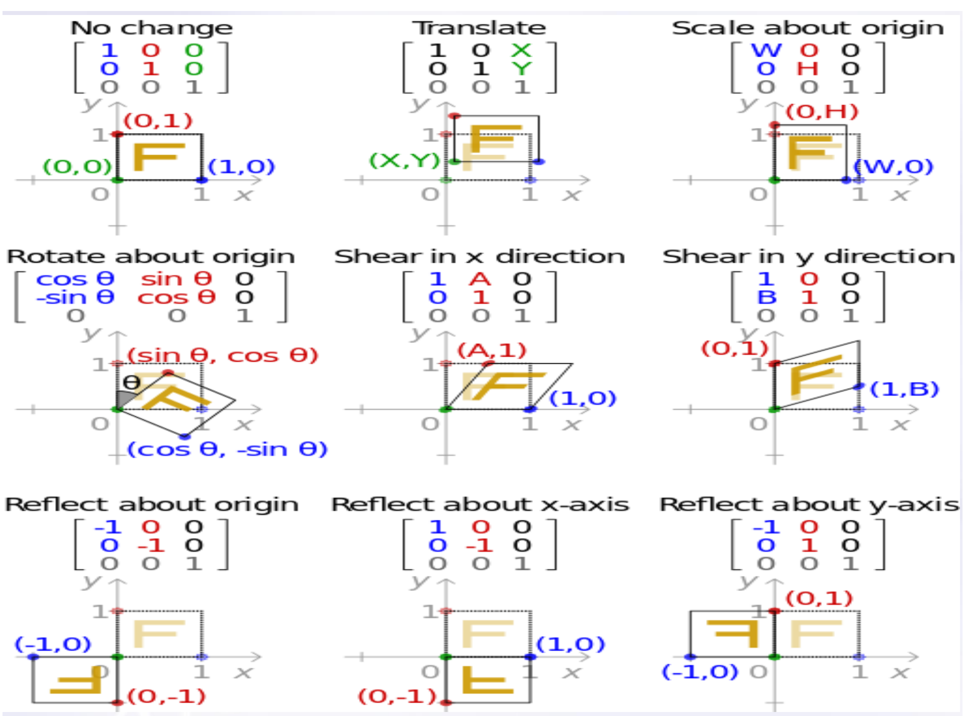

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Orginal Image

Wrapt Image

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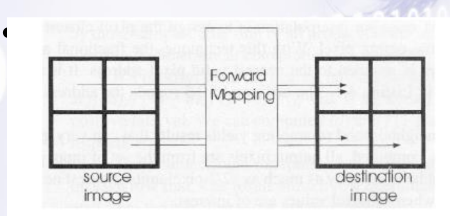
Forward mapping

- Transformed pixel coordinates might not lie within the bounds of the image.
- Transformed pixel coordinates can be non-integer.
- in the input image locations in the



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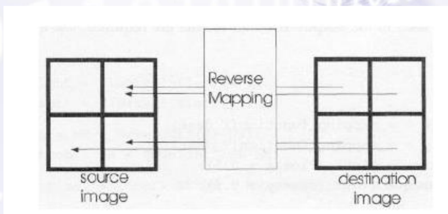
Inverse Mapping

- To guarantee that a value is generated for every pixel in the output image, we must consider each output pixel in turn and use the *inverse* mapping to determine the position in the input image.
- To assign intensity values to these locations, we use intensity *interpolation*.



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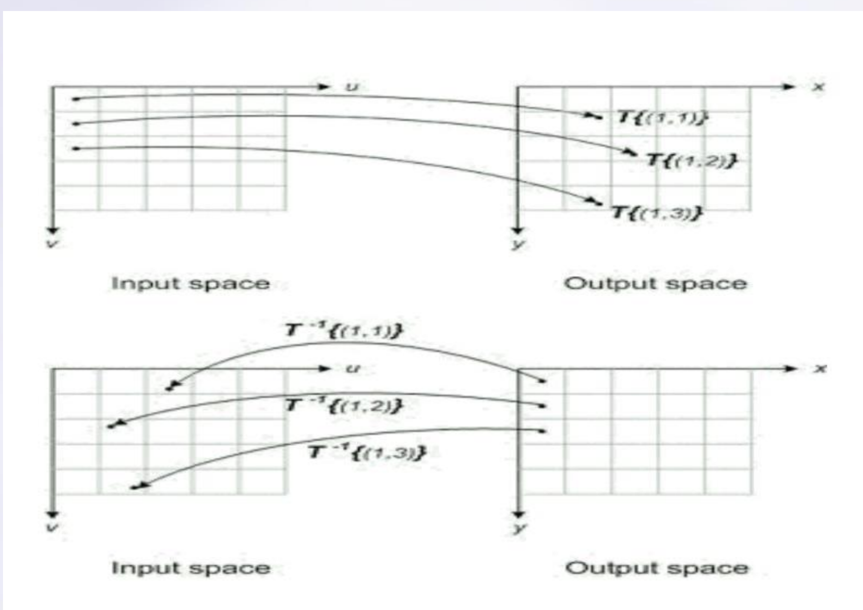

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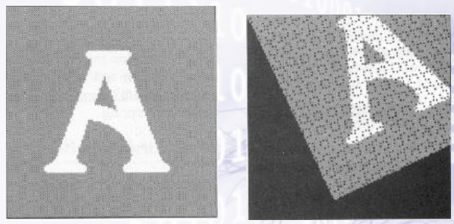
Forward mapping (cont’)

- An example of holes due to image rotation



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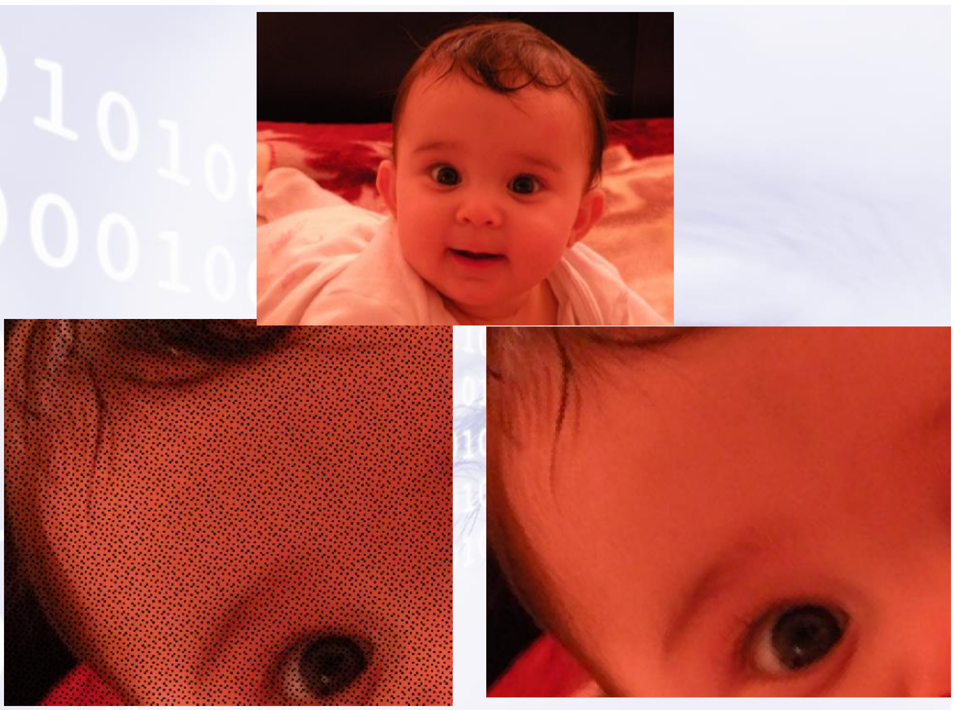

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Interpolation

- Interpolation is the process of using known data to estimate values at unknown locations.

<u>Zero-order interpolation (or nearest-neighbor)</u>

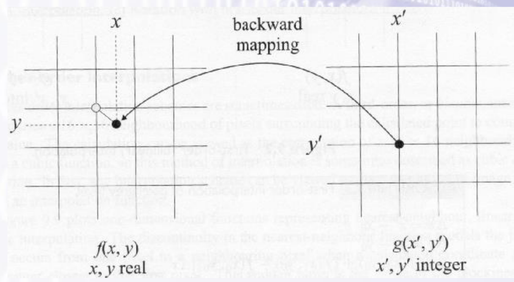

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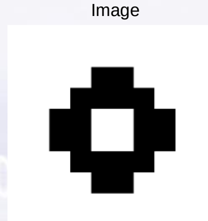
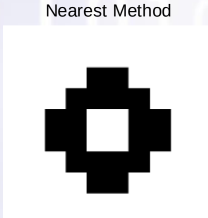
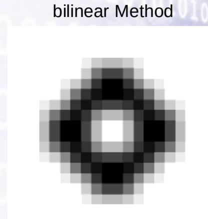
Image



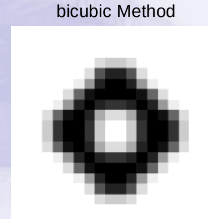
Nearest Method



bilinear Method



bicubic Method



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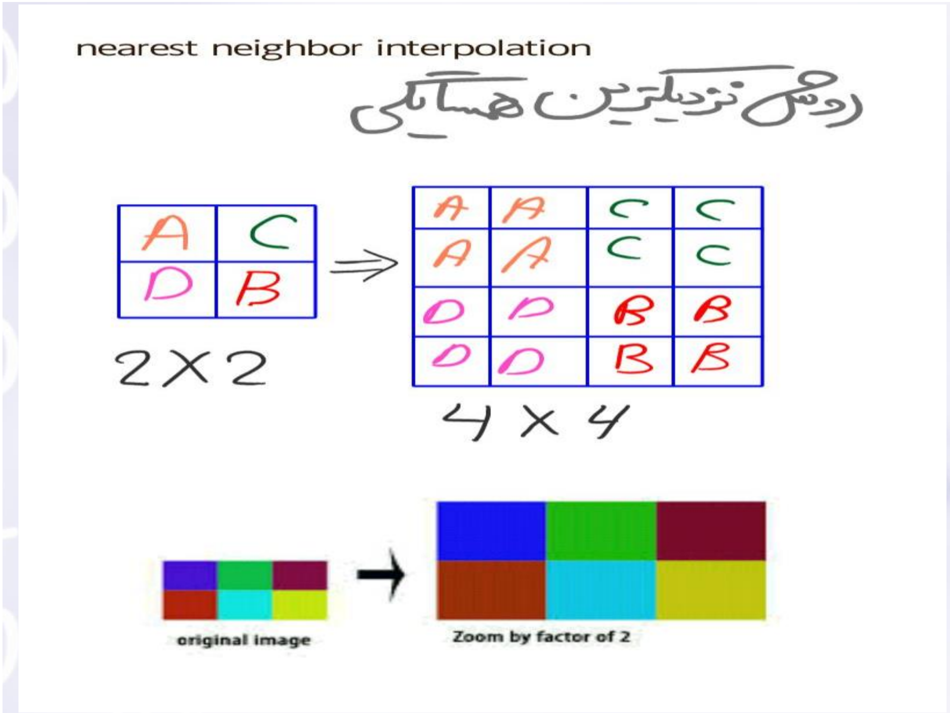

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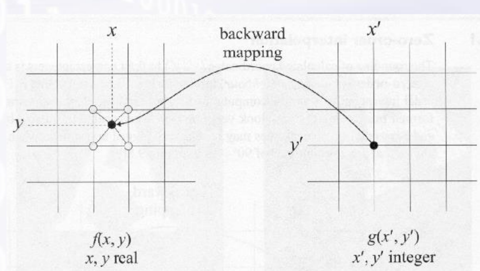
Interpolation (cont'd)

First-order interpolation:

average



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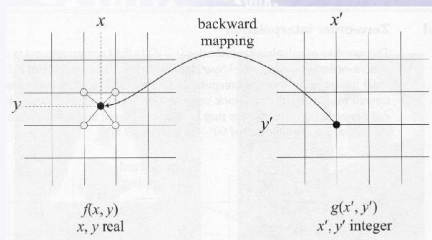
Interpolation (cont'd)

First-order interpolation:

bilinear

$I(x,y) = ax + by + cxy + d$



- The unknowns (a,b,c,d) are determined from four equations formed by the four nearest neighbors.

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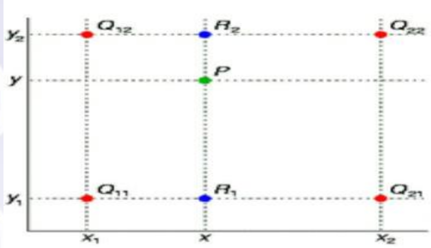
bilinear Interpolation



We first do linear interpolation in the x-direction. This yields

$$f(R_1) \approx \frac{x_2 - x}{x_2 - x_1} f(Q_{11}) + \frac{x - x_1}{x_2 - x_1} f(Q_{21})$$

where $R_1 = (x, y_1)$,

$$f(R_2) \approx \frac{x_2 - x}{x_2 - x_1} f(Q_{12}) + \frac{x - x_1}{x_2 - x_1} f(Q_{22})$$

where $R_2 = (x, y_2)$.

We proceed by interpolating in the y-direction.

$$f(P) \approx \frac{y_2 - y}{y_2 - y_1} f(R_1) + \frac{y - y_1}{y_2 - y_1} f(R_2).$$

Unit Square

If we choose a coordinate system in which the four points where f is known are (0, 0), (0, 1), (1, 0), and (1, 1), then the interpolation formula simplifies to

$$f(x,y) \approx f(0,0)\,(1-x)(1-y) + f(1,0)\,x(1-y) + f(0,1)\,(1-x)y + f(1,1)xy.$$

Or equivalently, in matrix operations:

$$f(x,y) \approx \begin{bmatrix} 1-x & x \end{bmatrix} \begin{bmatrix} f(0,0) & f(0,1) \\ f(1,0) & f(1,1) \end{bmatrix} \begin{bmatrix} 1-y \\ y \end{bmatrix}.$$

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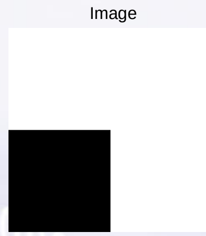
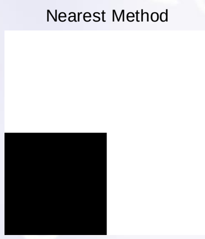
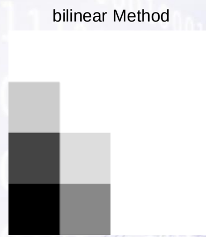
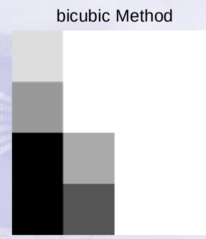


1	4
0	2







IM_nearest =

1	1	4	4
1	1	4	4
0	0	2	2
0	0	2	2

IM_bilinear =

1.0000	1.7500	3.2500	4.0000
0.7500	1.4375	2.8125	3.5000
0.2500	0.8125	1.9375	2.5000
0	0.5000	1.5000	2.0000

IM_bicubic =

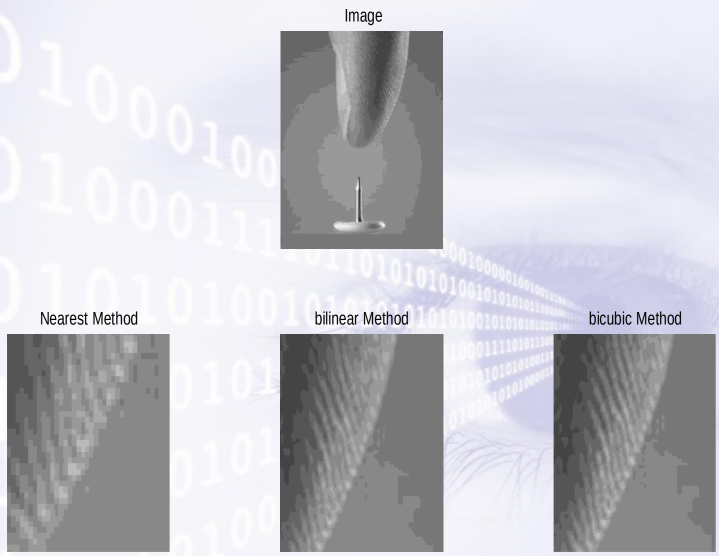
0.8544	1.6940	3.5170	4.3565
0.6002	1.3650	3.0256	3.7904
0.0482	0.6506	1.9587	2.5612
-0.2060	0.3217	1.4674	1.9951

Interpolation (cont'd)

Bicubic interpolation

- It involves the sixteen nearest neighbors of a point.
- The unknowns a_{ij} are determined from sixteen equations formed by the sixteen nearest neighbors.

$$I(x,y)=\sum_{i=0}^{3}\sum_{j=0}^{3}a_{ij}x^i y^j$$



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