08 - Image Enhancement

(Bagian 1 – Update 2023)

IF4073 Interpretasi dan Pengolahan Citra

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Image Enhancement

- *Image enhancement* = perbaikan kualitas citra agar tampak lebih baik
- Tujuan: memperoleh citra yang lebih sesuai digunakan untuk aplikasi lebih lanjut (missal untuk mengenali objek di dalam citra).
- Merupakan satu proses awal (*preprocessing*) di dalam computer vision
- Mengapa memerlukan *image enhancement*?

  - citra sering mengandung derau (*noise*)

  - citra terlihat terlalu terang/gelap, citra kurang tajam, kabur (*blur*)

  - ada cacat saat akuisisi citra disebabkan oleh:
    - lensa: *object blurring* atau *background blurring*
    - objek bergerak/kamera bergerak: *motion blurring*

  - Distorsi geometrik disebabkan oleh lensa atau sudut pengambilan gambar

Noisy image

Citra dengan kontras terlalu gelap

Motion blur

Dark face image for recognition

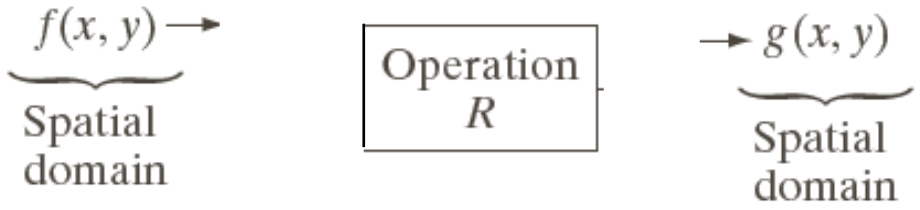
Blur vehicle plate number

- Berdasarkan ranah (domain) operasinya, metode-metode untuk perbaikan kualitas citra dapat dikelompokkan menjadi dua kategori:

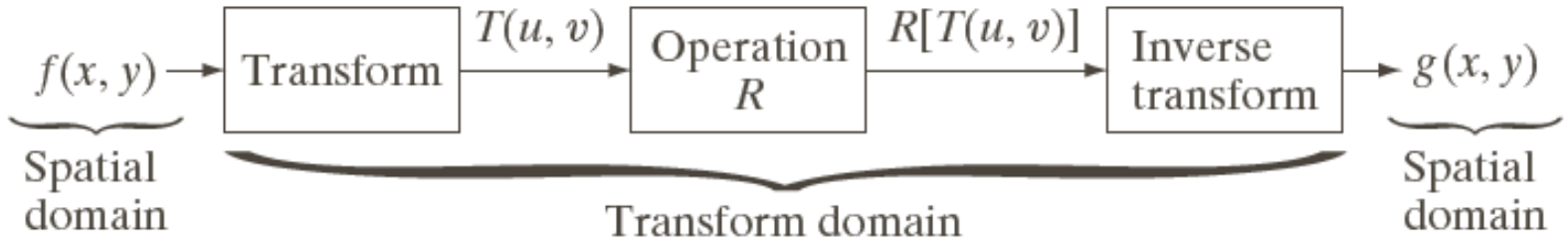
  1. *Image enhancement* dalam ranah spasial

  2. *Image enhancement* dalam ranah frekuensi

    - Spatial Domain



    - Frequency Domain (misalnya menggunakan *Fourier Transform*)



Sumber gambar: *Image Fitering*, CS485/685 Computer Vision, Prof. George Bebis

- Metode-metode *image enhancement* dalam ranah spasial dilakukan dengan memanipulasi secara langsung *pixel-pixel* di dalam citra.

- Metode-metode *image enhancement* dalam ranah frekuensi dilakukan dengan mengubah citra terlebih dahulu dari ranah spasial ke ranah frekuensi, baru kemudian memanipulasi nilai-nilai frekuens tersebut.

- Masing-masing ranah operasi digunakan untuk tujuan spesifik, karena tidak semua perbaikan citra dapat dilakukan dalam ranah spasial.

- Materi di dalam PPT ini membahas metode-metode *image enhancement* dalam ranah spasial terlebih dahulu.

Metode dalam Ranah Spasial

- Misalkan:
  - f(x,y) : citra input
  - g(x,y) : citra output
  - T adalah operator terhadap f

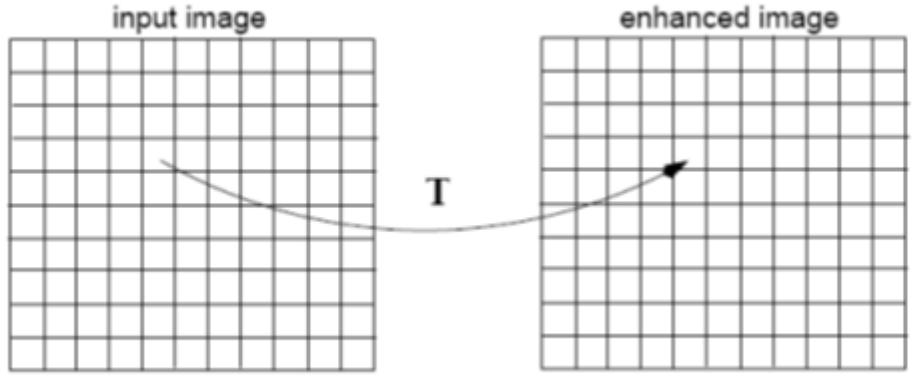
- Metode pemrosesan citra dalam ranah spasial dinyatakan sebagai:

$$g(x,y) = T [f(x,y)]$$

- T bisa beroperasi pada satu *pixel*, sekelompok *pixel* bertetangga, atau keseluruhan pixel di dalam citra.

- Jadi, metode dalam ranah spasial dapat dilakukan pada aras titik (pixel), aras lokal, dan aras global.

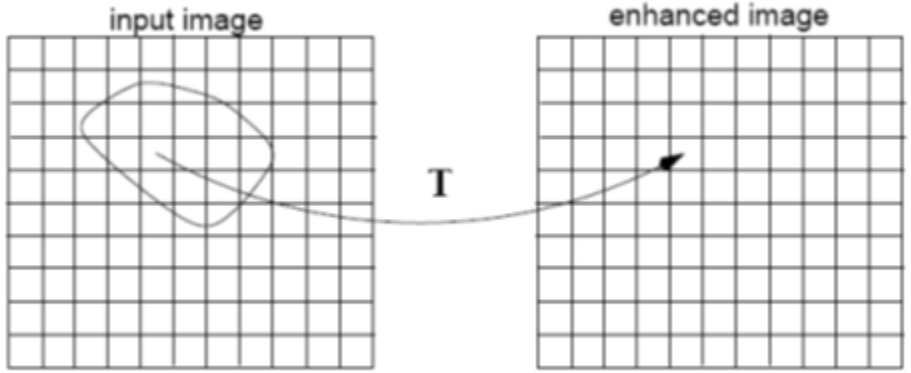
Aras titik



$g(x,y) = T[f(x,y)]$

T operates on 1 pixel

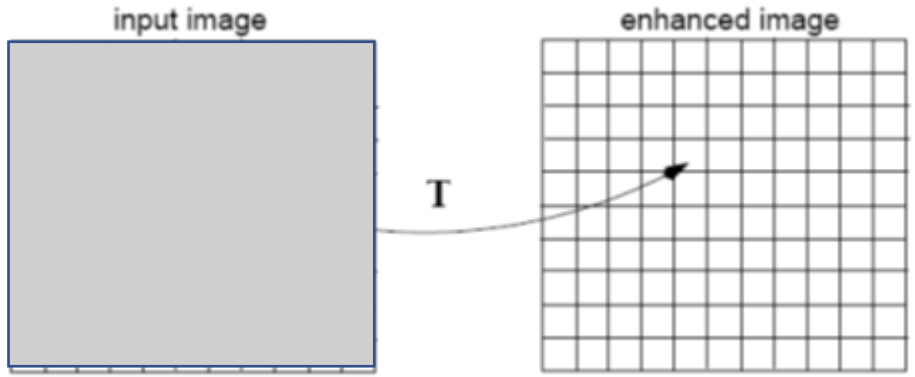
Aras lokal



$g(x,y) = T[f(x,y)]$

T operates on a neighborhood of pixels

Aras global



g(x,y) = T[f(x,y)]
T operates on entire of pixels

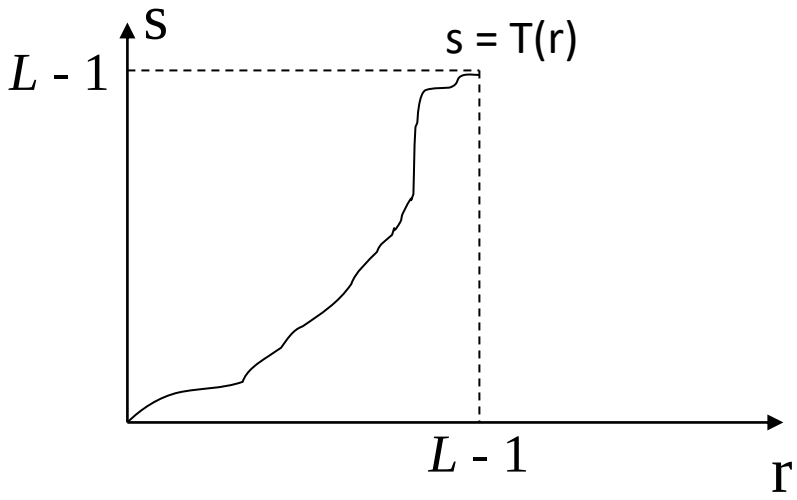
- Proses-proses yang termasuk ke dalam perbaikan kualitas citra:
  - ❑ Pengubahan kecerahan gambar (*image brightening*)
  - ❑ Citra negatif (*image negatives*)
  - ❑ Peregangan kontras (*contrast stretching*)
  - ❑ Pengubahan histogram citra.
  - ❑ Pelembutan citra (*image smoothing)*
  - ❑ Penajaman citra (*image sharpening*)
  - ❑ Perbaikan distorsi geometrik
  - ❑ Dll

- Operasi perbaikan kualitas citra dapat dilakukan dalam aras titik, aras lokal, atau aras global, bergantung pada metodenya.

Pemrosesan dalam aras titik (*pixel wise*)

- g(x,y) = T [f(x,y)]
- T hanya beroperasi pada *pixel* tunggal
- T adalah fungsi transformasi nilai *grayscale*, sehingga ditulis:

s = T(r)



r : variabel yang menyatakan nilai *grayscale* f(x,y)

s : variabel yang menyatakan nilai *grayscale* g(x,y)

L = 256: pada citra grayscale 8-bit

Contoh-contoh *image enhancement* dalam aras titik:

1. Mencerahkan citra (*image brightening*)
2. Menegatifkan citra (*image negatives*)
3. Peregangan kontras (*contrast stretching*)
4. *Gamma correction*
5. dll

- Perlu dipahami perbedaan antara kecerahan (*brightness*) dan kontras (*contrast*).
- *Brightness* adalah intensitas *pixel* relatif dengan *pixel* lainnya


Normal brightness


Underexposure

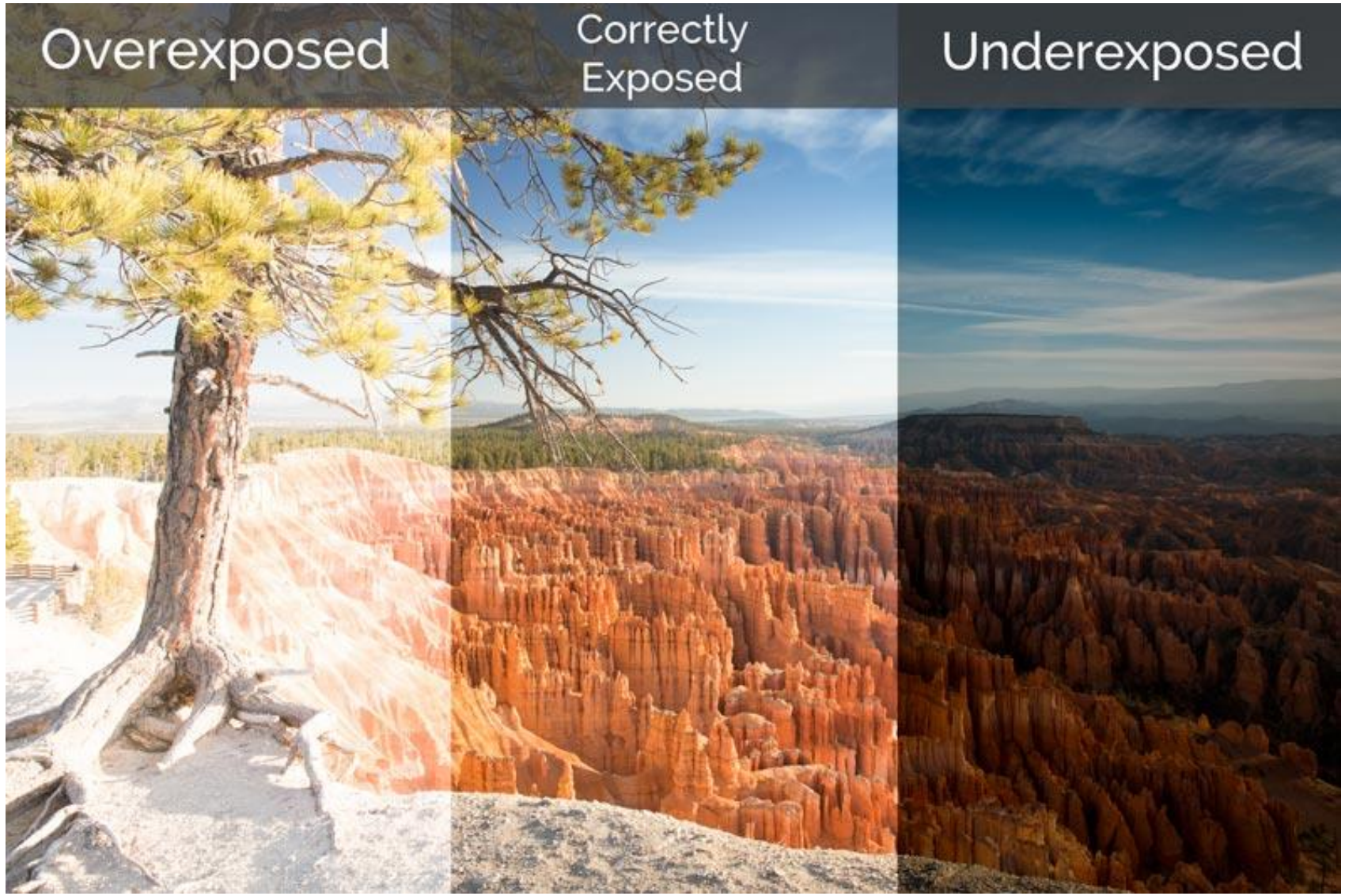

Overexposure

- Kontras adalah perbedaan antara nilai maksimum (terang) dan nilai minimum (gelap) pixel


Normal contrast

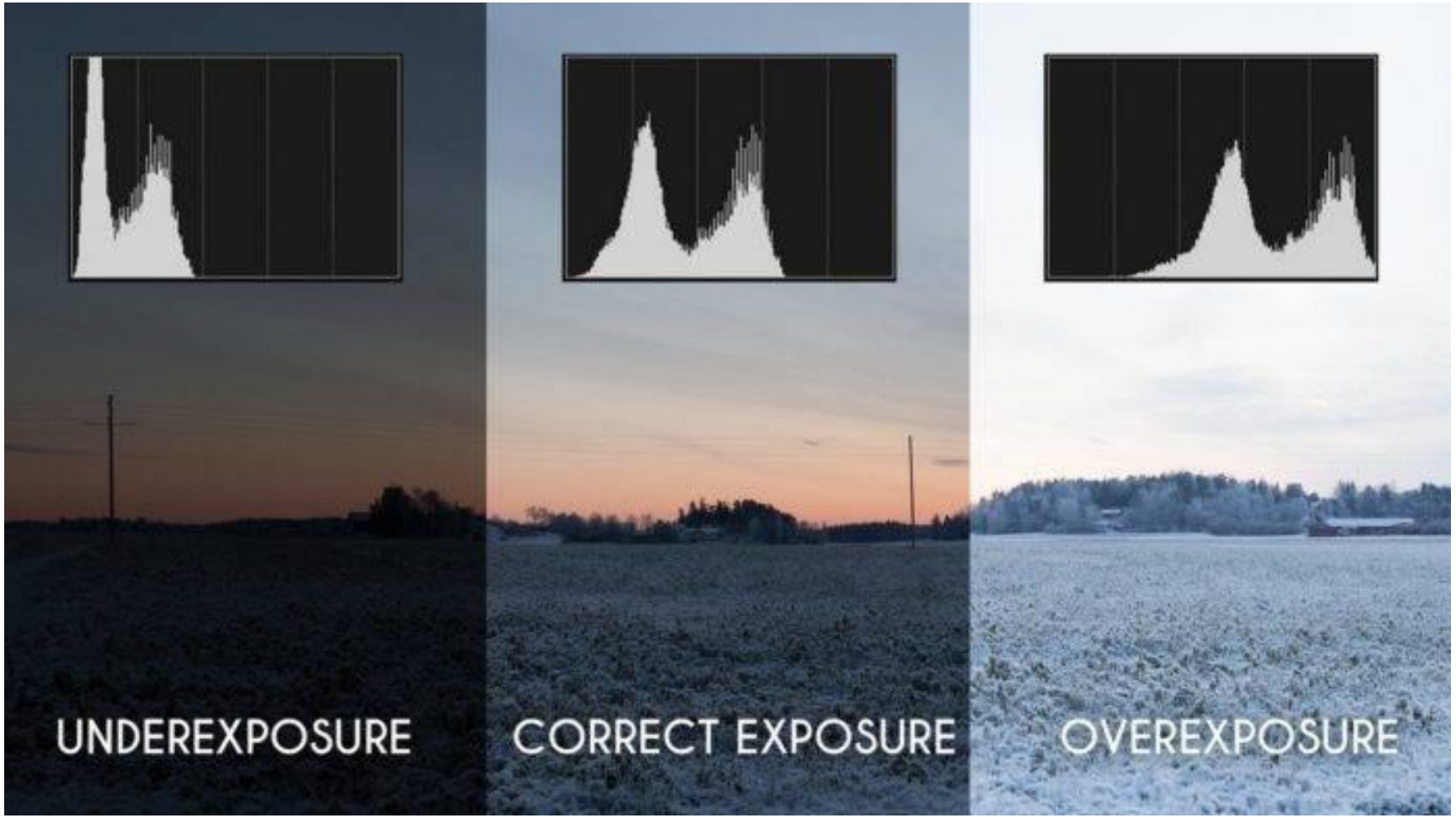

low contrast


high contrast



https://shuttermuse.com/glossary/overexposure/

- Perbedaan histogram pada *underexposure*, *normal*, dan *overexposure* image



Menumpuk di kiri

Tersebar lebih merata

Menumpuk di kanan

Low Contrast Image

High Contrast Image

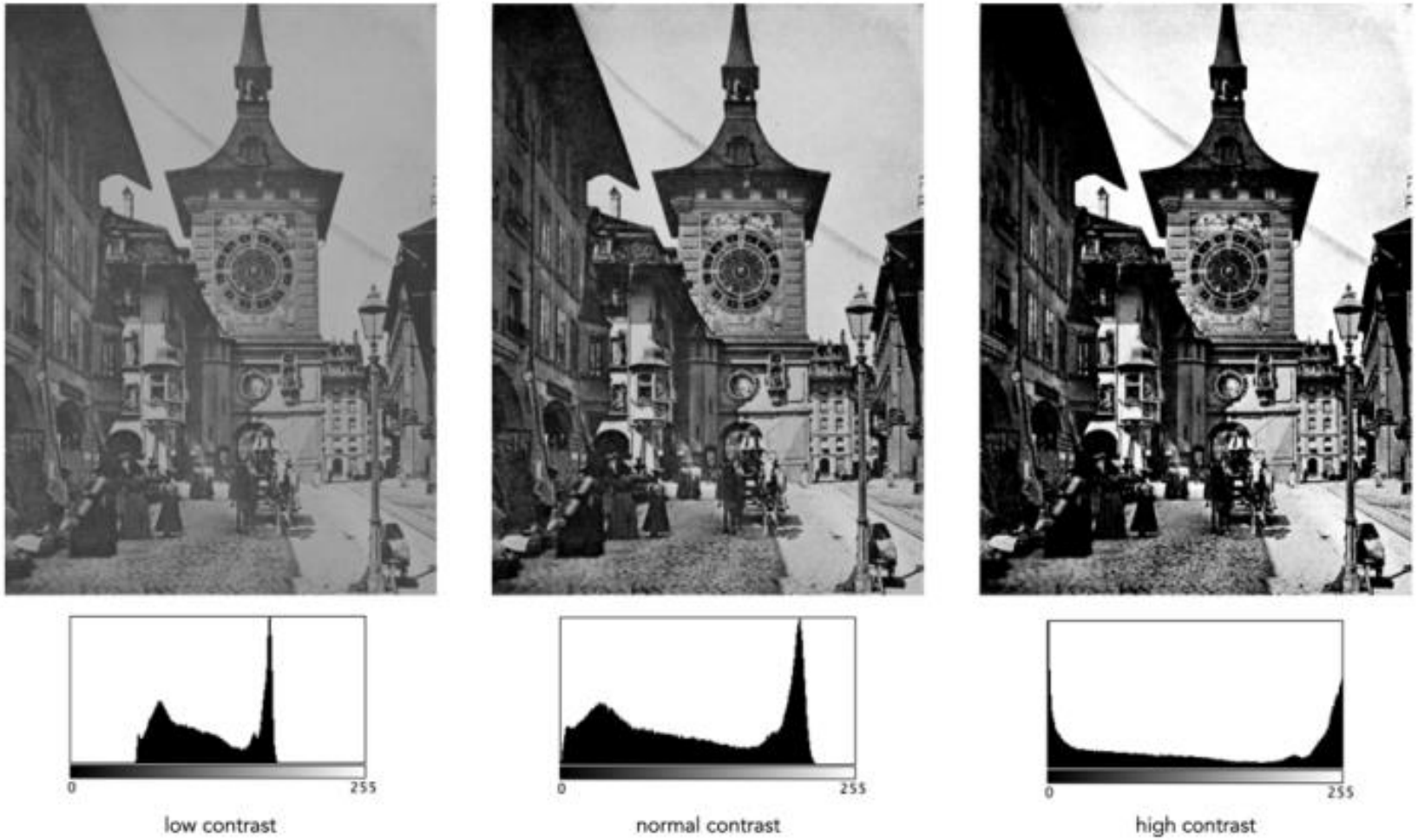
https://theailearner.com/2019/01/30/what-is-contrast-in-image-processing/

LOW CONTRAST

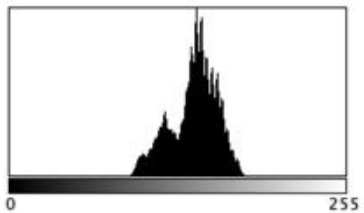
BALANCED

HIGH CONTRAST

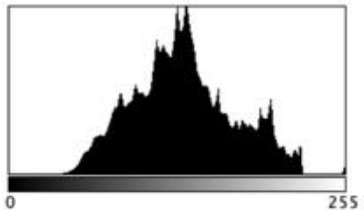
- Perbedaan histogram pada citra *low-contrast*, *high contrast*, dan *normal contrast*



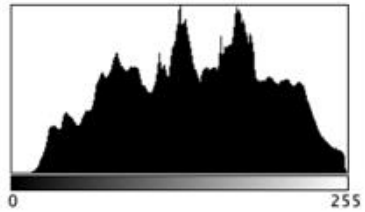
low contrast image



medium contrast image



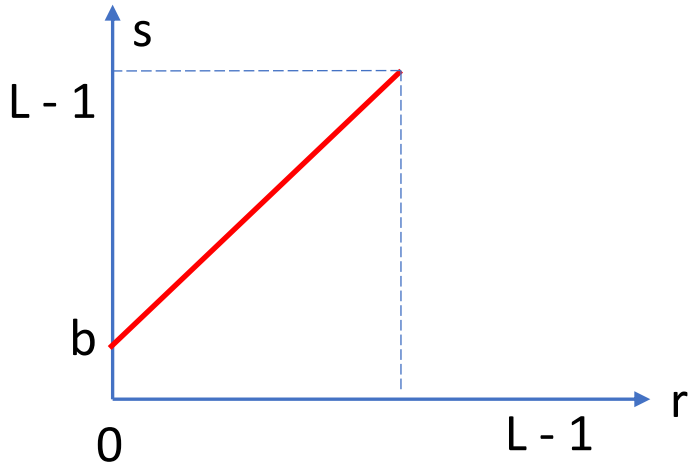
high contrast image



1. Pencerahan citra (*image brightening*)

- Kecerahan citra dapat diperbaiki dengan menambahkan/mengurangkan sebuah konstanta kepada (atau dari) setiap *pixel,* atau mengalikan sebuah konstansta ke setiap *pixel*.

$$s = r + b$$



- Jika *b* positif, kecerahan citra bertambah,

  Jika *b* negatif kecerahan citra berkurang

- Perlu operasi *clipping* jika nilai *r* + *b* berada di bawah nilai intensitas minimum atau di atas nilai intensitas maksimum:

  - jika $r + b > 255$, maka $s = 255$

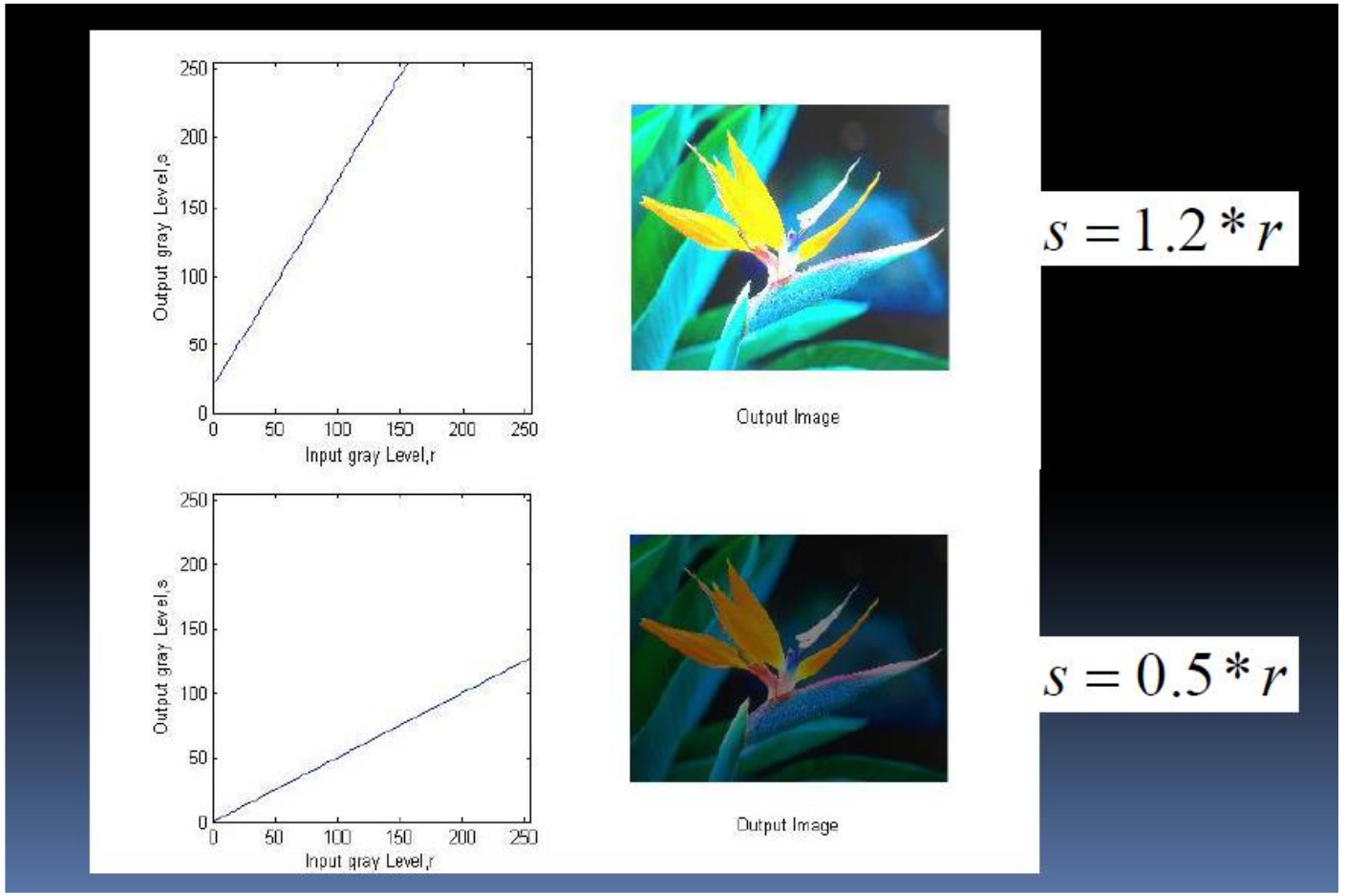
  - jika $r + b < 0$, maka $s = 0$

Gambar Kiri: citra Zelda (agak gelap); kanan: citra Zelda setelah operasi pencerahan citra, $b = 100$

- Operasi pencerahan yang lain adalah menggunakan rumus:

$$s = ar + b$$

a dan *b* adalah konstanta



Sumber gambar: Ehsan Khoramshahi, *Image enhancement in spatial domain*

```
f = imread('lada256.bmp');
imshow(f)
g = 1.5 * f + 30;
figure, imshow(g)
h = 0.5 * f + 10;
figure, imshow(h)
```

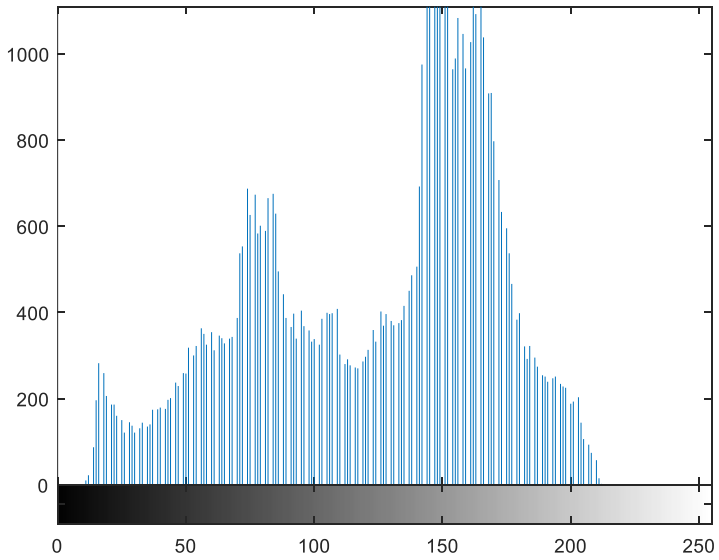
f

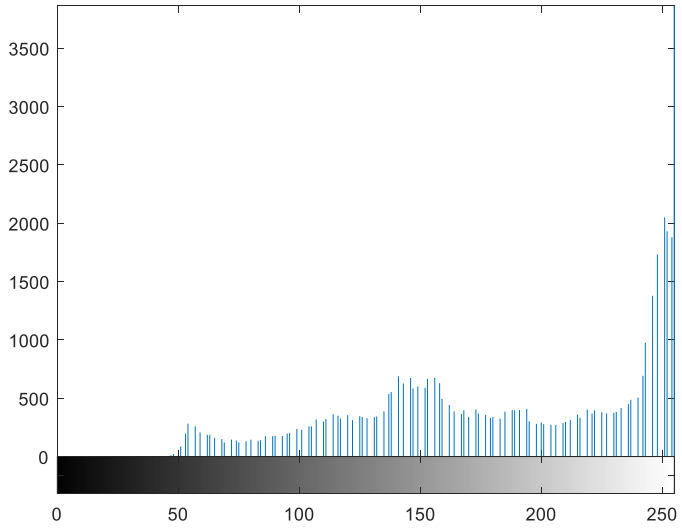
g = 1.5 * f + 30;

h = 0.5 * f + 10;

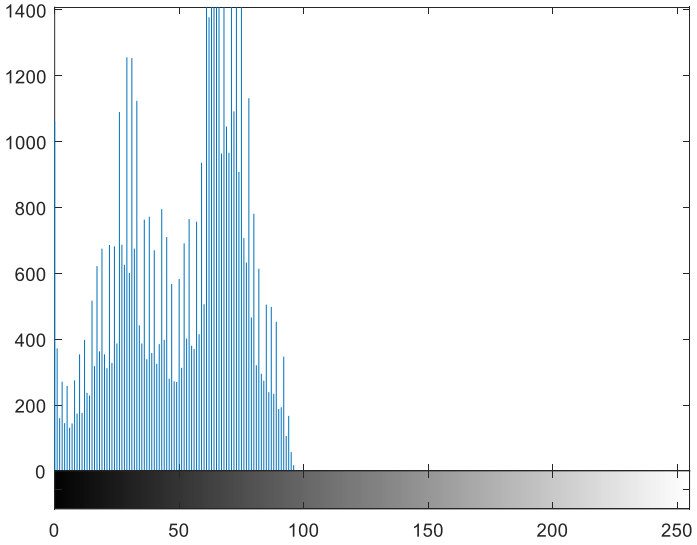
```
f = imread('bird.bmp');
imshow(f);
figure, imhist(f);
g = 1.5 * f + 30;
figure, imshow(g)
figure, imhist(g);
h = 0.5 * f - 10;
figure, imshow(h);
figure, imhist(h);
```

f





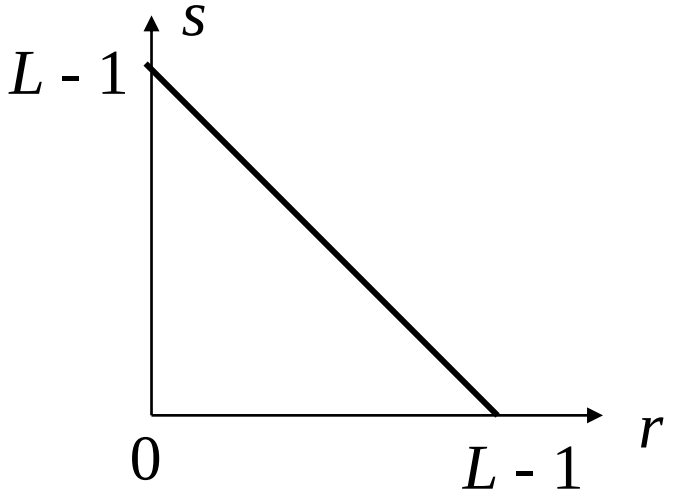
g = 1.5 * f + 30;



h = 0.5 * f - 10;

2. Menegatifkan Citra (*Image Negatives*)

- Seperti film negatif pada fotografi.
- Misalkan citra memiliki *L* derajat keabuan
- Caranya: kurangi nilai intensitas *pixel* dari nilai keabuan maksimum (*L* – 1)



$$s = (L - 1) - r$$

Contoh pada citra *grayscale* 8-bit:

$$s = 255 - r$$

```
f = imread('girl.jpg');
g = 255 - f;
imshow(f), title('Original image');
figure, imshow(g), title('Negative image');
```

Original image

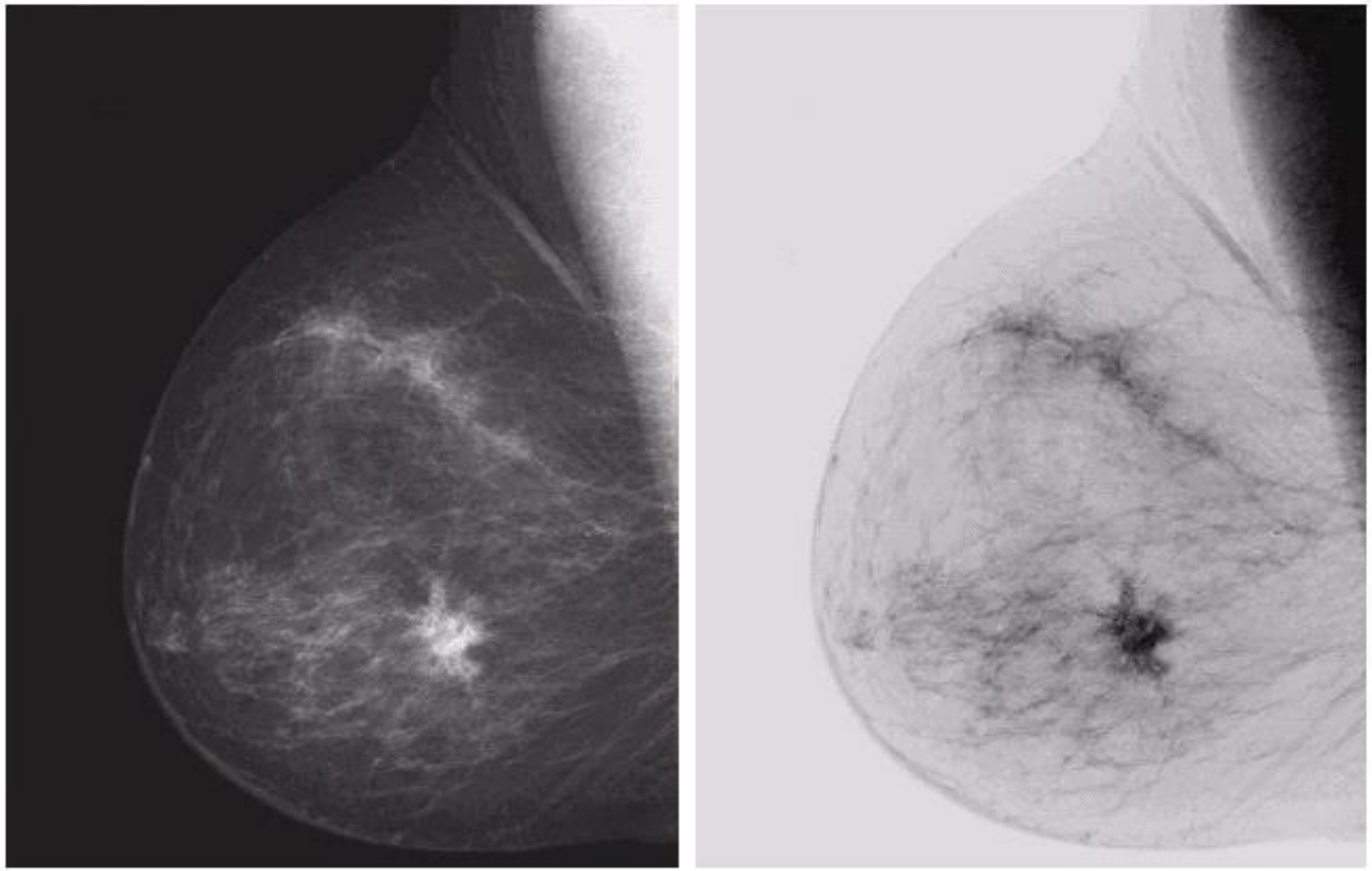
Negative image

```
f = imread('gedung-sate.jpg');
g = 255 - f;
imshow(f), title('Original image');
figure, imshow(g), title('Negative image');
```

Original image

Negative image

- Sebagai proses *image enhancement*, menegatifkan citra bermanfaat bila area hitam sangat dominan di dalam citra, misalnya foto sinar-X dan citra mammografi.



a b

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.)

Input image (X-ray image)

Output image (negative)

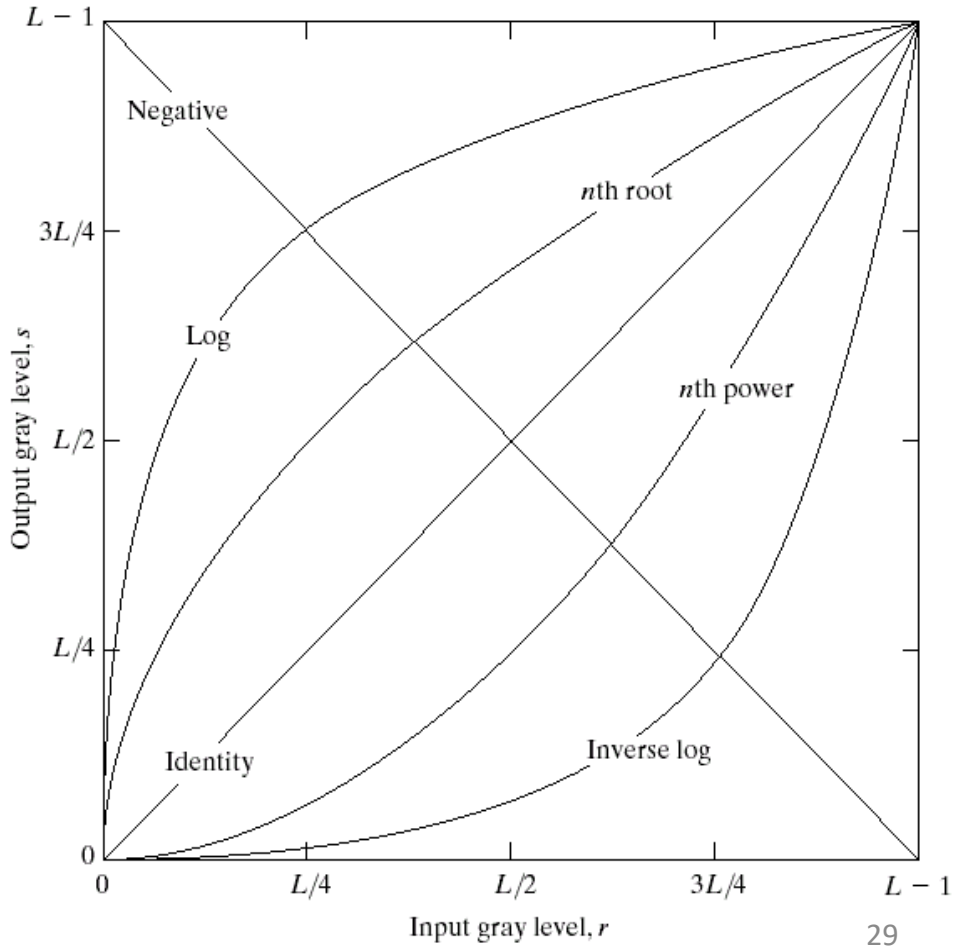
- Menegatifkan citra adalah salah satu transformasi linier. Selain transformasi linier, terdapat tiga fungsi transformasi dasar keabuan:

1. Fungsi linier
   - Transformasi negatif dan transformasi identitas

2. Fungsi logaritma
   - Transformasi log dan inverse-log

3. Fungsi pangkat
   - Transformasi pangkat *n* dan transformasi akar pangkat *n*

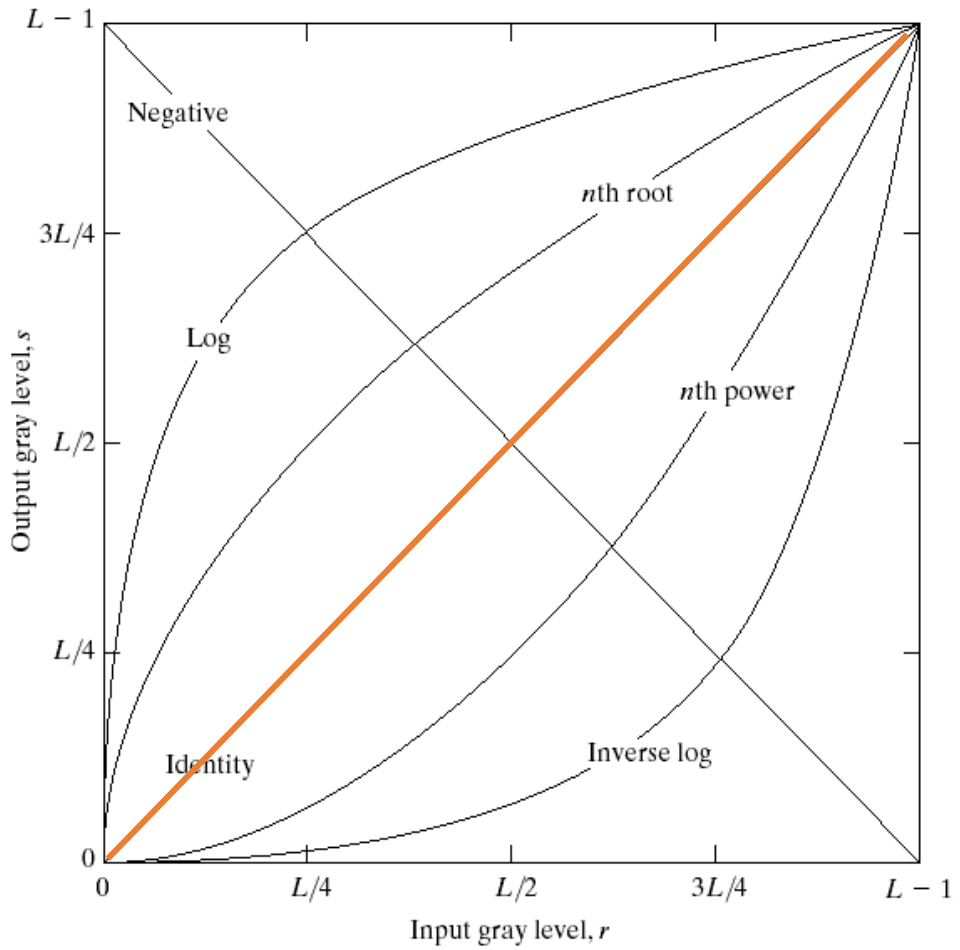
FIGURE 3.3 Some basic gray-level transformation functions used for image enhancement.



a) Transformasi identitas

- Nilai keabuan citra *output* sama dengan keabuan citra *input*
- Dimasukkan ke dalam grafik hanya untuk melengkapi

FIGURE 3.3 Some basic gray-level transformation functions used for image enhancement.



b) Transformasi Log

- Fungsi $s = c \log(1+r)$

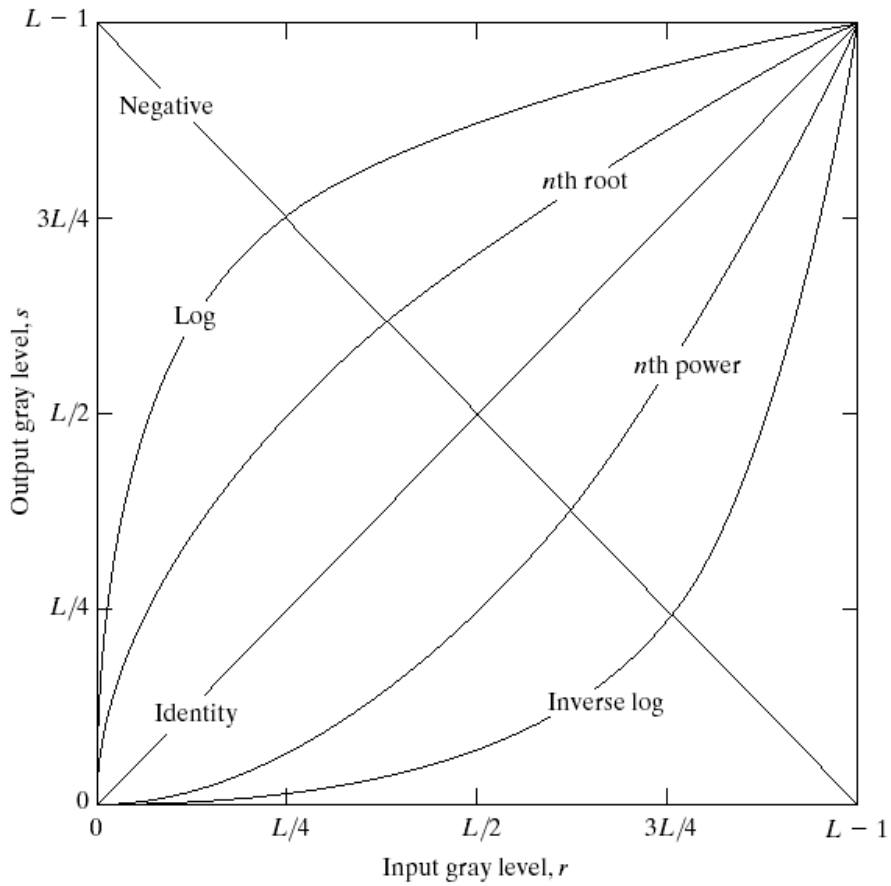
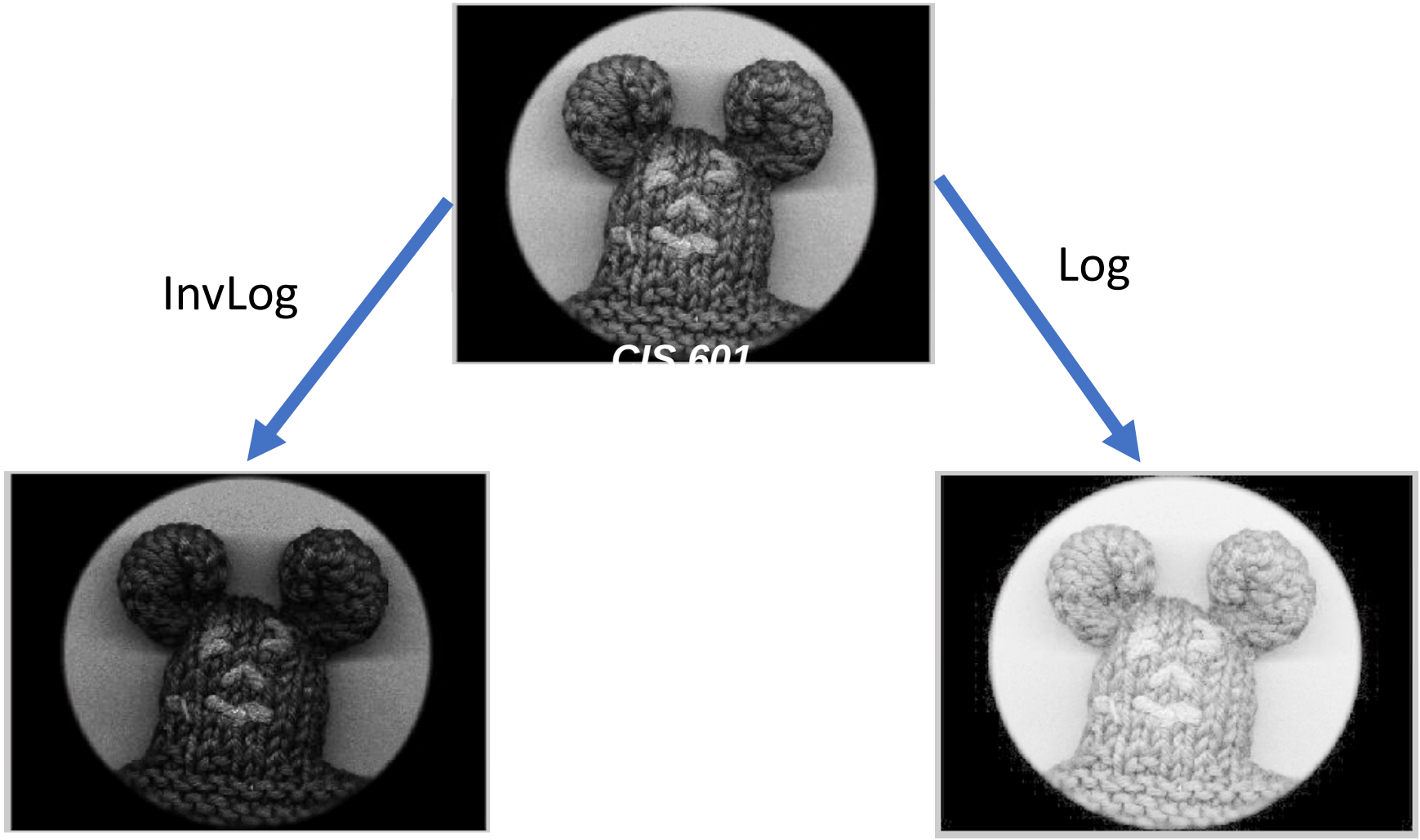


FIGURE 3.3 Some basic gray-level transformation functions used for image enhancement.

- Transformasi log memiliki sifat:
  1. Untuk citra yang memiliki rentang yang sempit untuk nilai-nilai keabuan yang rendah (gelap), dipetakan menjadi rentang yang lebih luas pada citra luaran.

  2. Untuk citra yang memiliki rentang yang lebar untuk nilai-nilai keabuan yang tinggi (terang), dipetakan menjadi rentang yang lebih sempit pada citra luaran

- Pada transformasi log balikan (*inverse*), yang terjadi adalah kebalikannya.



Sumber gambar: CIS 601, Image ENHANCEMENT in the SPATIAL DOMAIN, *Dr. Rolf Lakaemper*

Transformasi Log

```
clc
clear
a=imread('cameraman.bmp');
imshow(a), title ('Original image');
a=im2double(a);
[row,col]=size(a);
c = 2;
for i=1:row
 for j=1:col
   s(i,j)= c*log(a(i,j) + 1);
 end
end
figure, imshow(s), title ('Log
transformation image');
```

Original image

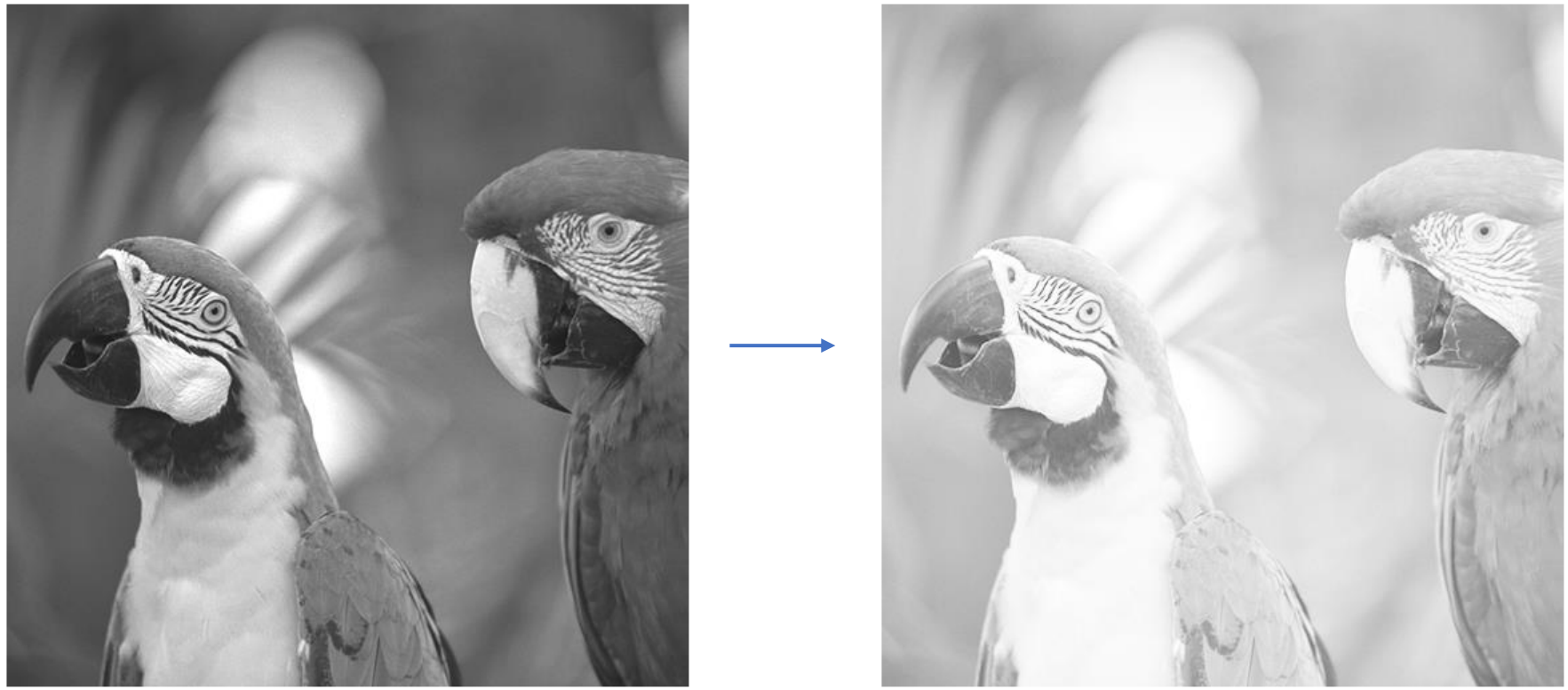
Log transformation image

Transformasi Inverse Log

```
clc
clear
a=imread('cameraman.bmp');
imshow(a), title ('Original image');
a=im2double(a);
[row,col]=size(a);
c = 2;
for i=1:row
 for j=1:col
   s(i,j)= exp(a(i,j)^c) - 1;
 end
end
figure, imshow(s), title ('Inverse log
transformation image');
```

Original image

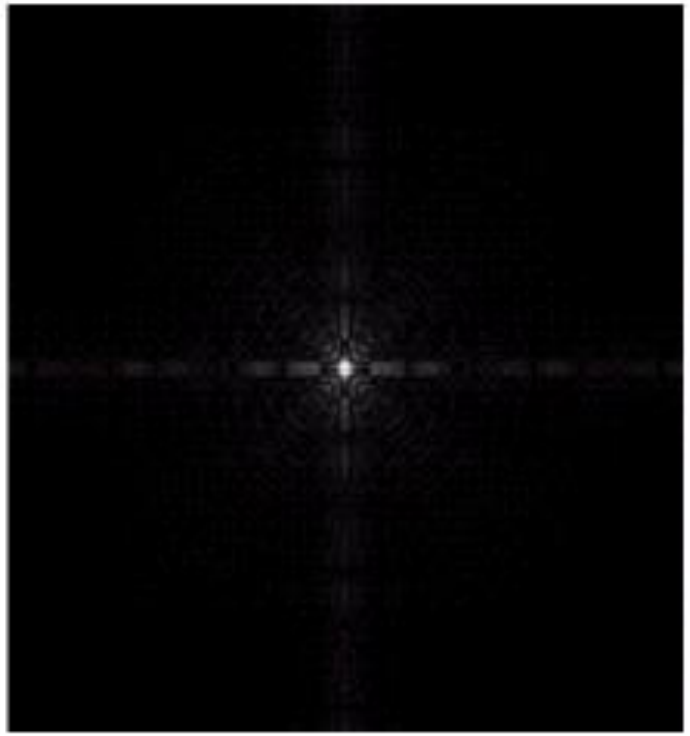
Inverse log transformation image



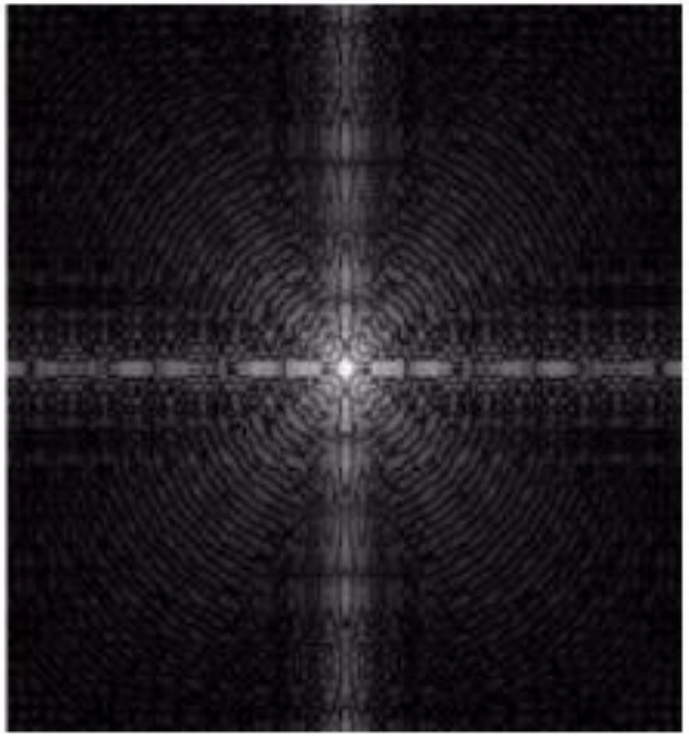
Sumber: Digital Image Processing, Chapter # 3, Image Enhancement in Spatial Domain

Application:

- *This transformation is suitable for the case when the dynamic range of a processed image far exceeds the capability of the display device (e.g. display of the Fourier spectrum of an image)*
- *Also called "dynamic-range compression / expansion"*



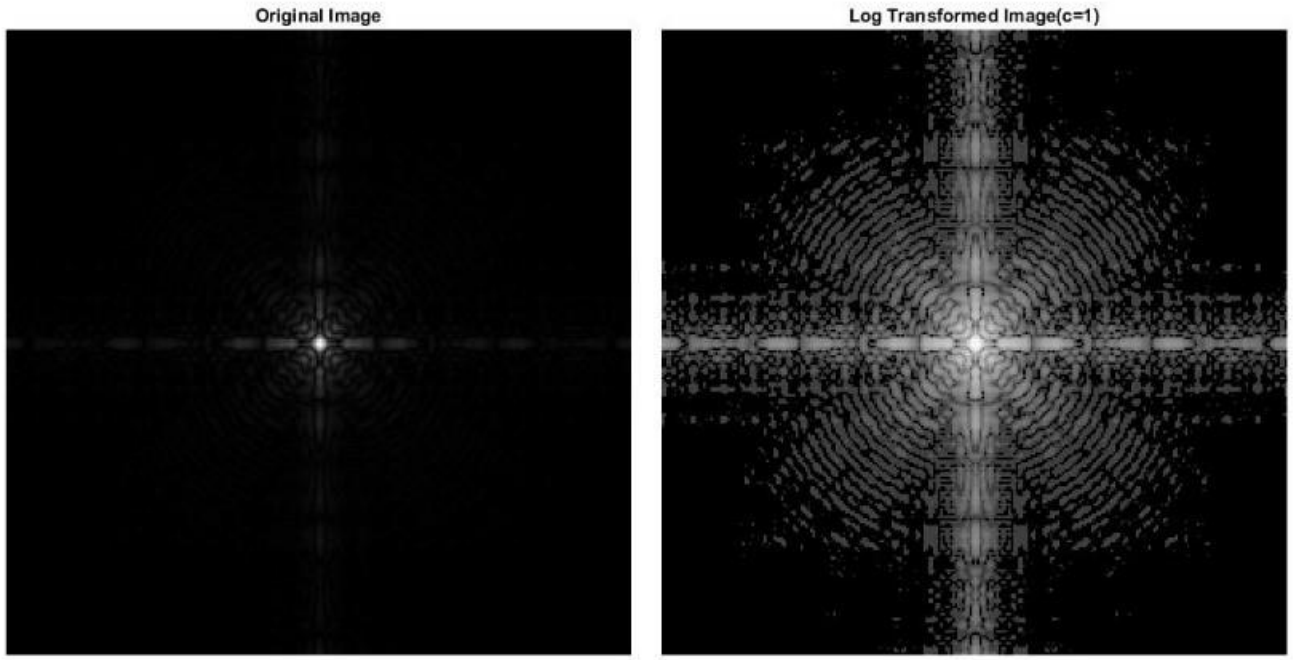
Fourier spectrum with values of range 0 to 1.5×10^6 scaled linearly



The result applying log transformation, $c = 1$

```
clc; clear all;

in=imread('fourier.jpg');
c=input('Enter the constant value, c = ');
a=im2double(in);
a=a*255;
out=c*log10(1+a);          % s=T(r)=clog(1+r)
out=out/max(max(out));     % Normalization
subplot(121), imshow(in), title('Original Image')
subplot(122), imshow(out), title('Log Transformed Image(c=1)')
```



http://matlabwork.blogspot.com/2016/03/basic-intensity-transformation-functions.html

c) Transformasi Pangkat

- Fungsi pangkat:

$$s = cr^{\gamma}$$

c dan γ adalah konstanta positif.

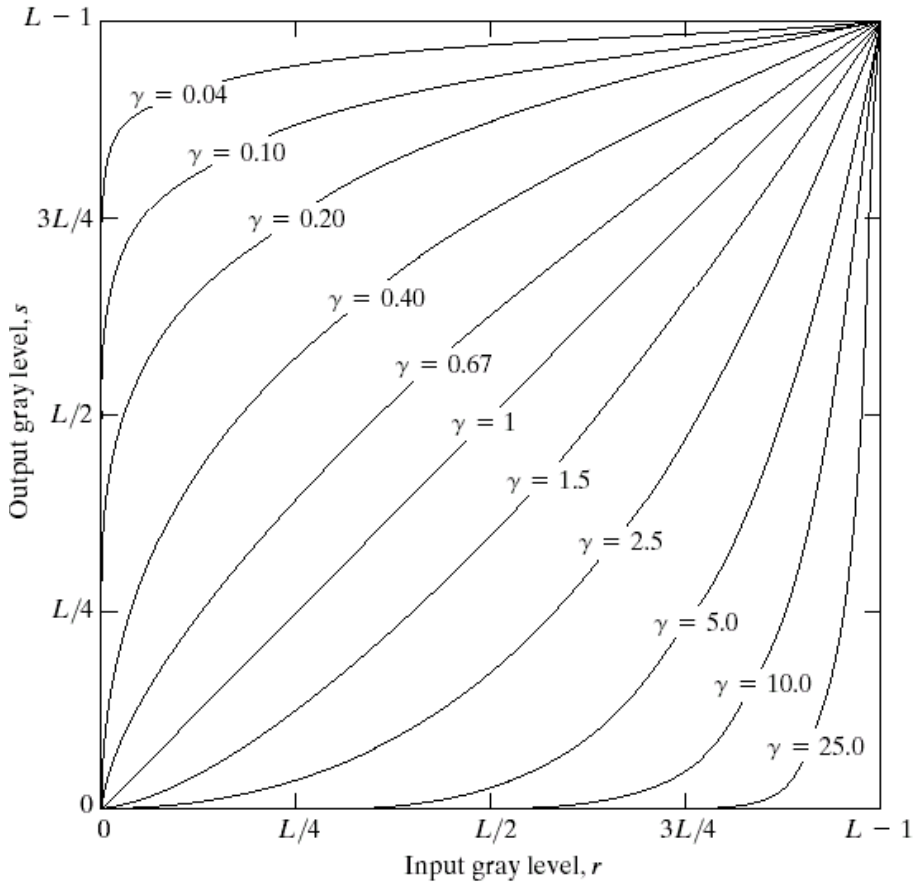
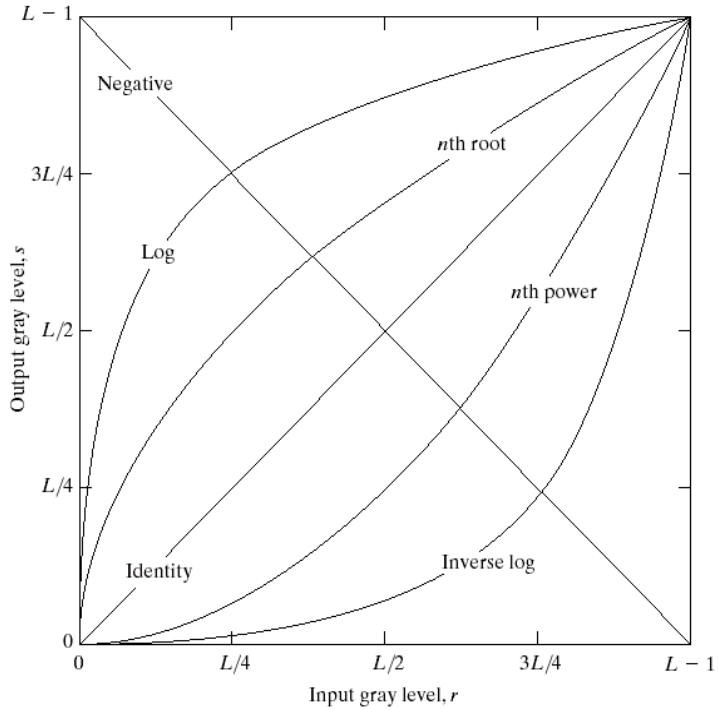


FIGURE 3.6 Plots of the equation $s = cr^{\gamma}$ for various values of γ ($c = 1$ in all cases).

FIGURE 3.3 Some basic gray-level transformation functions used for image enhancement.



Hukum pangkat (*power-law*):

Untuk γ < 1: Membuat citra menjadi lebih terang

Untuk γ > 1: Membuat citra menjaid lebih gelap

Jika γ =1 & c=1: Transformasi identitas (s = r)

Beberapa devais (*image capture*, *printing*, *display*) melakukan respon berdasarkan hukum-pangkat dan perlu dikoreksi

Power transformation ($\gamma < 1$)

```
clc
clear
a=imread('cameraman.bmp');
imshow(a), title ('Original image');
a=im2double(a);
[row,col]=size(a);
gamma = 0.3;
c = 1;
for i=1:row
  for j=1:col
     s(i,j)= c *(a(i,j)^gamma);
  end
end
figure, imshow(s), title ('Power
tranformation image');
```

Original image

Power tranformation image

Power transformation ($\gamma > 1$)

```
clc
clear
a=imread('cameraman.bmp');
imshow(a), title ('Original image');
a=im2double(a);
[row,col]=size(a);
gamma = 3;
c = 1;
for i=1:row
  for j=1:col
     s(i,j)= c *(a(i,j)^gamma);
  end
end
figure, imshow(s), title ('Power
tranformation image');
```

Original image

Power tranformation image

Original image

Power tranformation image

$\gamma = 0.4$

Citra berwarna

```
clc
clear
a=imread('gedung-sate.jpg');
imshow(a), title ('Original image');
a=im2double(a);
gamma = 0.5; c = 1;
s = c * a.^gamma;
figure, imshow(s), title ('Power tranformation image');
```

Original image

Power tranformation image

MRI image of fractured human spine

Result of applying power-law transformation

$c = 1, \gamma = 0.6$

Result of applying power-law transformation

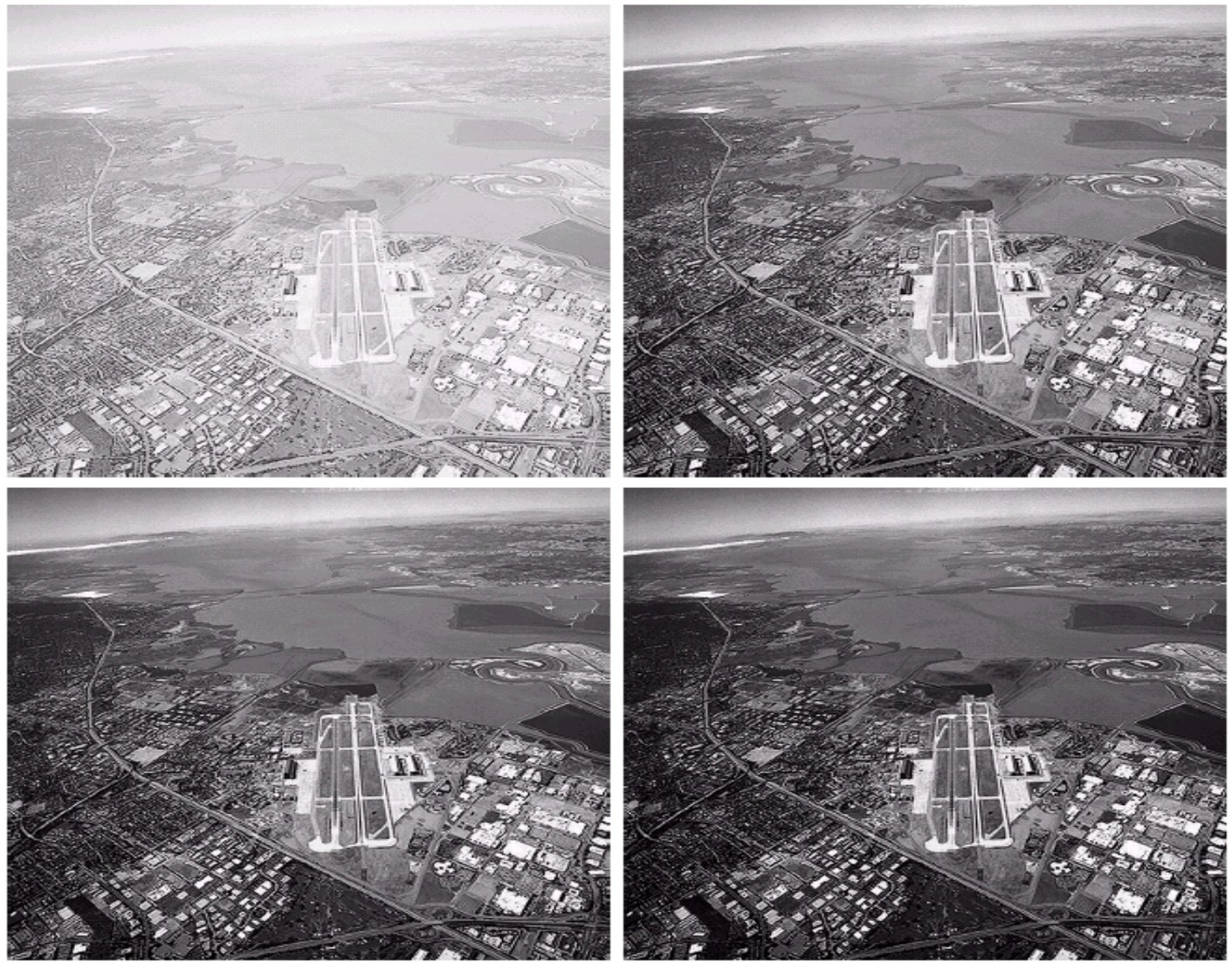
$c = 1, \gamma = 0.4$

Result of applying power-law transformation

$c = 1, \gamma = 0.3$

a b
c d

FIGURE 3.9
(a) Aerial image. (b)–(d) Results of applying the transformation in Eq. (3.2-3) with $c = 1$ and $\gamma = 3.0, 4.0$, and 5.0, respectively. (Original image for this example courtesy of NASA.)



Rincian:

Arial image

Result of a transformation for c=1 and γ=3

Rincian:

Result of a transformation for c=1 and γ=4

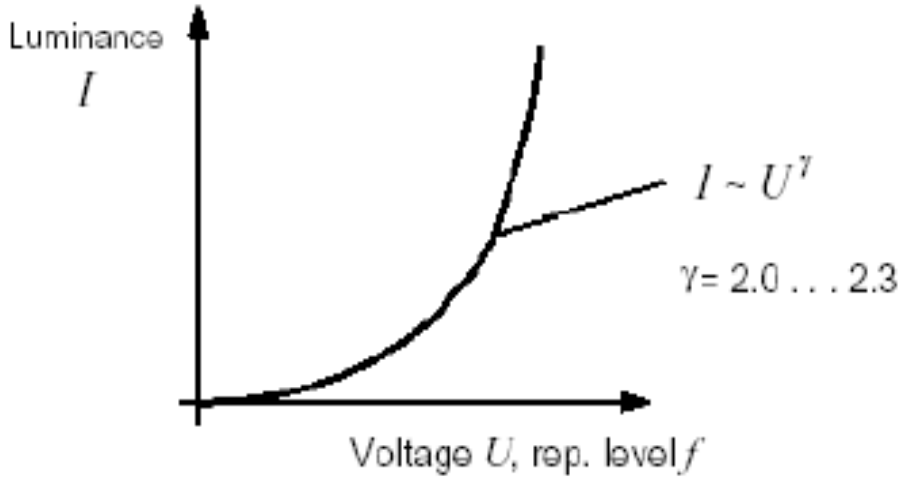
Result of a transformation for c=1 and γ=5

Gamma correction

Gamma (γ) correction: Proses yang digunakan untuk mengoreksi fenomena hukum-pangkat

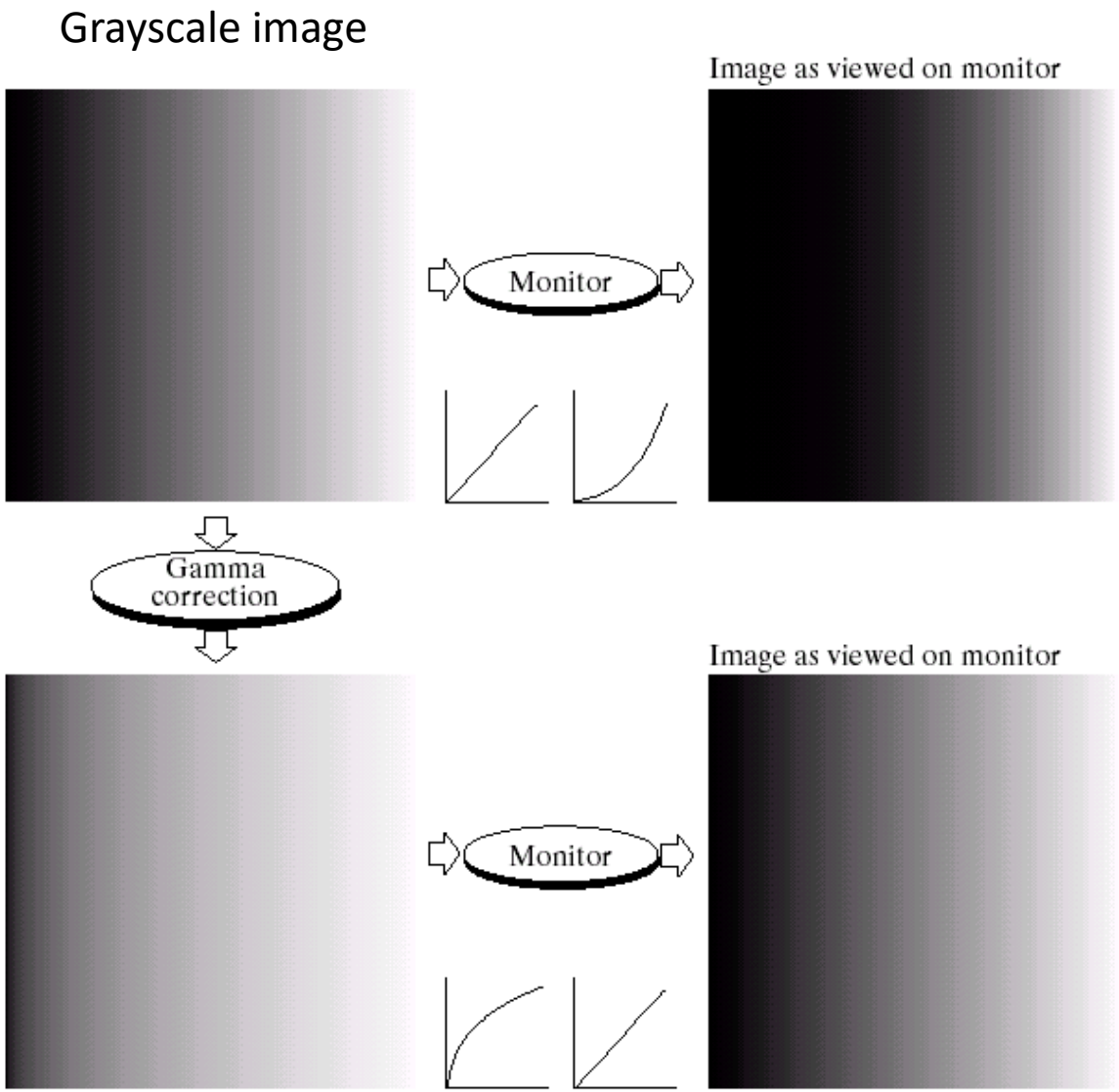
- Example of gamma correction

Cathode ray tubes (CRT) are nonlinear



- To linearize the CRT response a pre-distortion circuit is needed $s = cr^{1/\gamma}$

Gamma correction

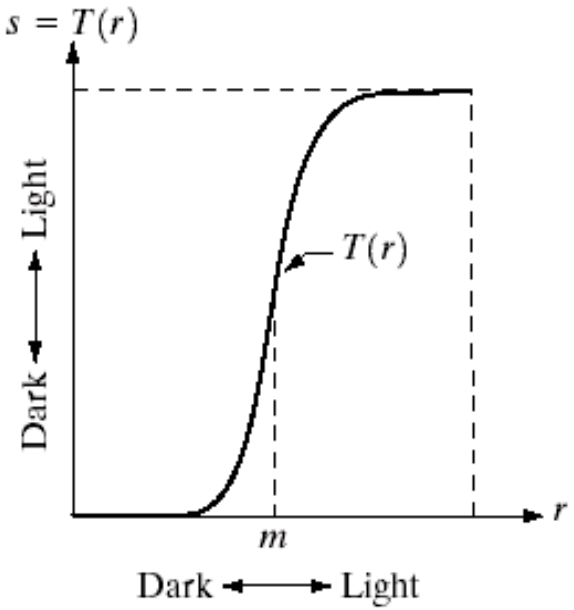


a b
c d

FIGURE 3.7
(a) Linear-wedge gray-scale image. (b) Response of monitor to linear wedge. (c) Gamma-corrected wedge. (d) Output of monitor.

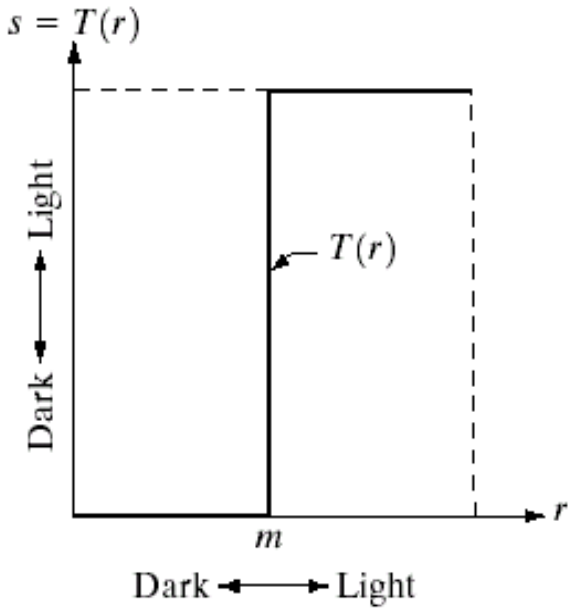
- Cathode ray tube (CRT) devices have an intensity-to-voltage response that is a power function, with γ varying from 1.8 to 2.5
- The picture will become darker.
- Gamma correction is done by preprocessing the image before inputting it to the monitor with $s = cr^{1/\gamma}$

3. Perbaikan kontras (*contrast enhancement*)



(a)

Contrast Stretching



(b)

Thresholding

- *r* = *graylevel* citra masukan
- *s* = *graylevel* citra luaran
- *T* = fungsi perbaikan kontras
- *m* = nilai ambang

(a) Nilai-nilai pixel < *m* dibuat lebih gelap
Nilai-nilai pixel ≥ *m* dibuat lebih terang
Operasi peregangan kontras (*contrast stretching*)

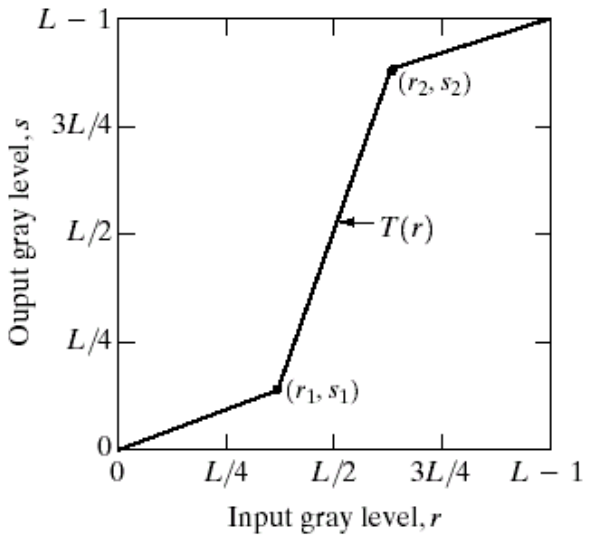
(b) Nilai-nilai pixel < *m* dibuat menjadi hitam
Nilai-nilai pixel ≥ *m* dibuat menjadi putih
Operasi pengambangan (*thresholding*)

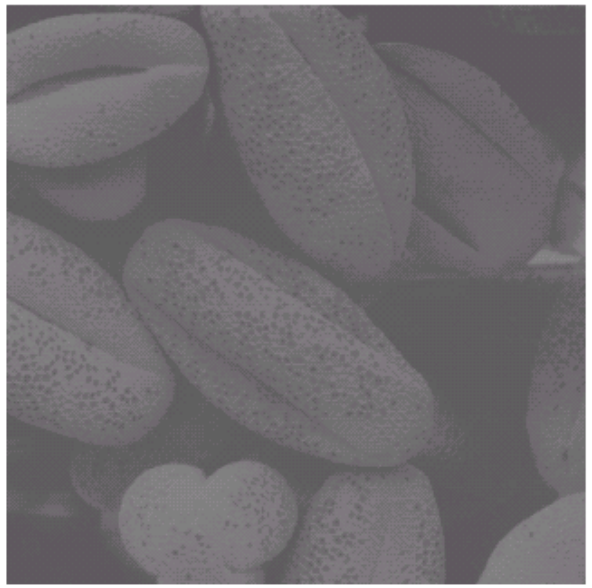
Original image

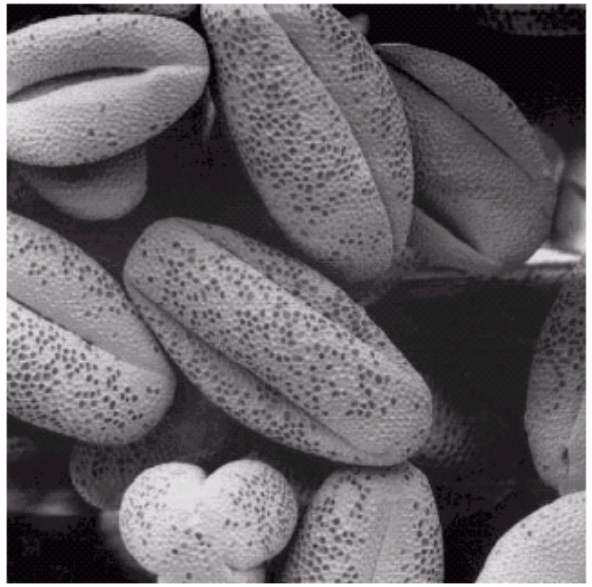
Peregangan kontras

Pengambangan

Contoh:







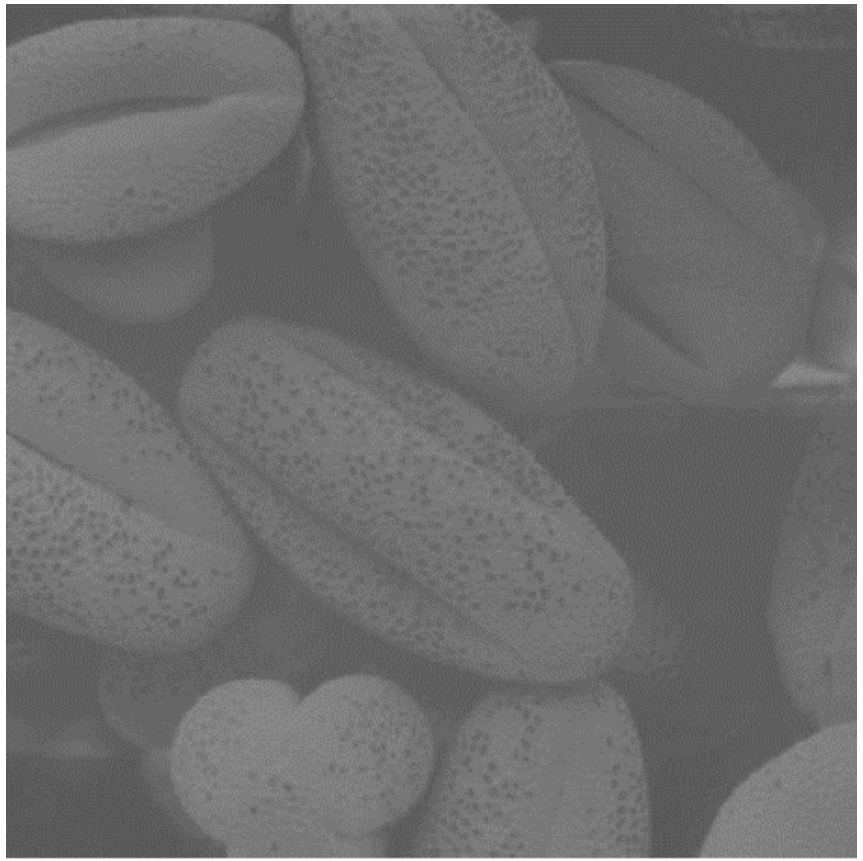
a b
c d

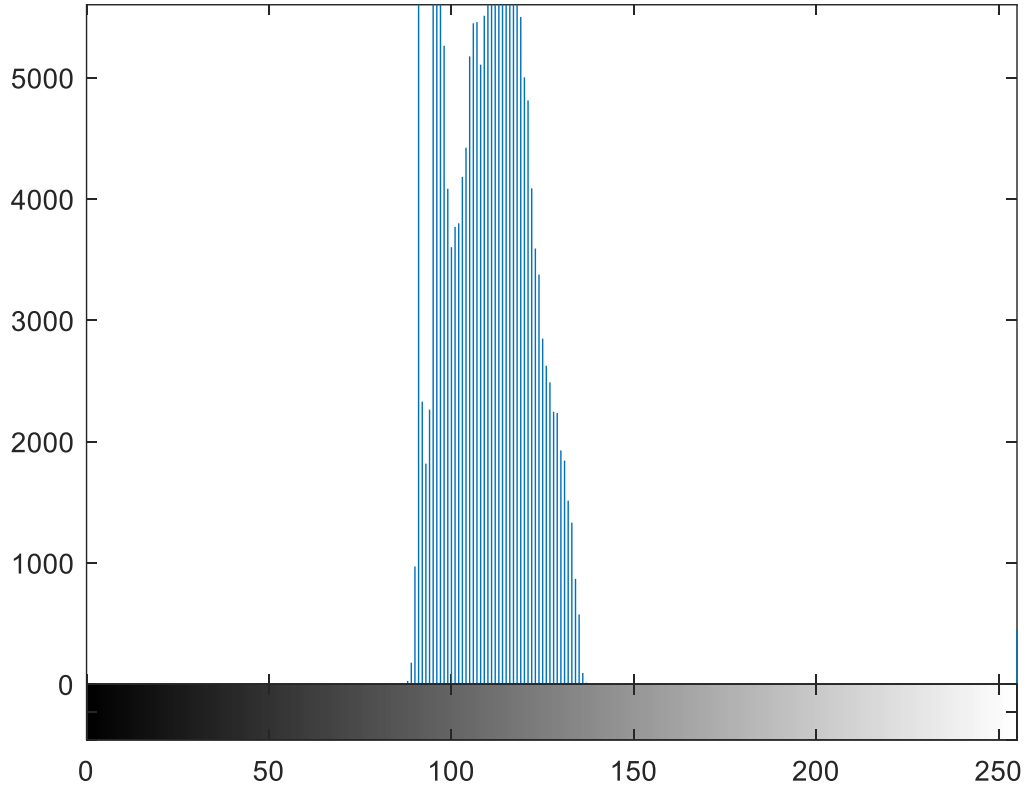
FIGURE 3.10 Contrast stretching. (a) Form of transformation function. (b) A low-contrast image. (c) Result of contrast stretching. (d) Result of thresholding. (Original image courtesy of Dr. Roger Heady, Research School of Biological Sciences, Australian National University, Canberra, Australia.)

Jika $r_1 = r_2 = m$, maka hasilnya sama dengan operasi pengambangan, menghasilkan citra biner, seperti gambar d

Peregangan kontras (*contrast stretching*)

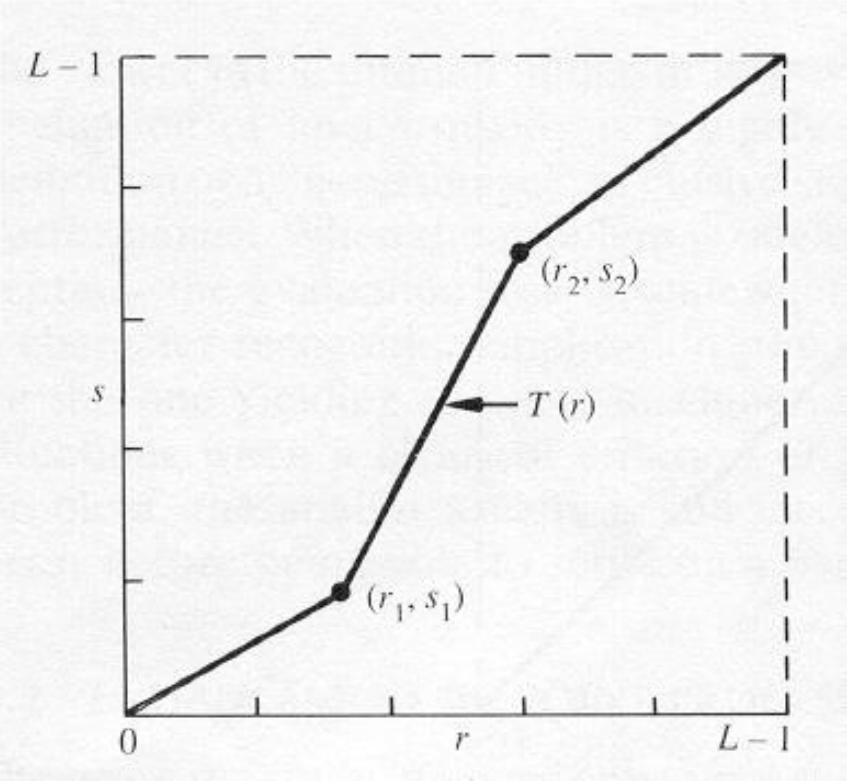
- Peregangan kontras merupakan metode sederhana untuk memperbaiki citra yang memiliki kontras rendah





Ciri-ciri citra kontras-rendah: histogram sempit menumpuk di tengah

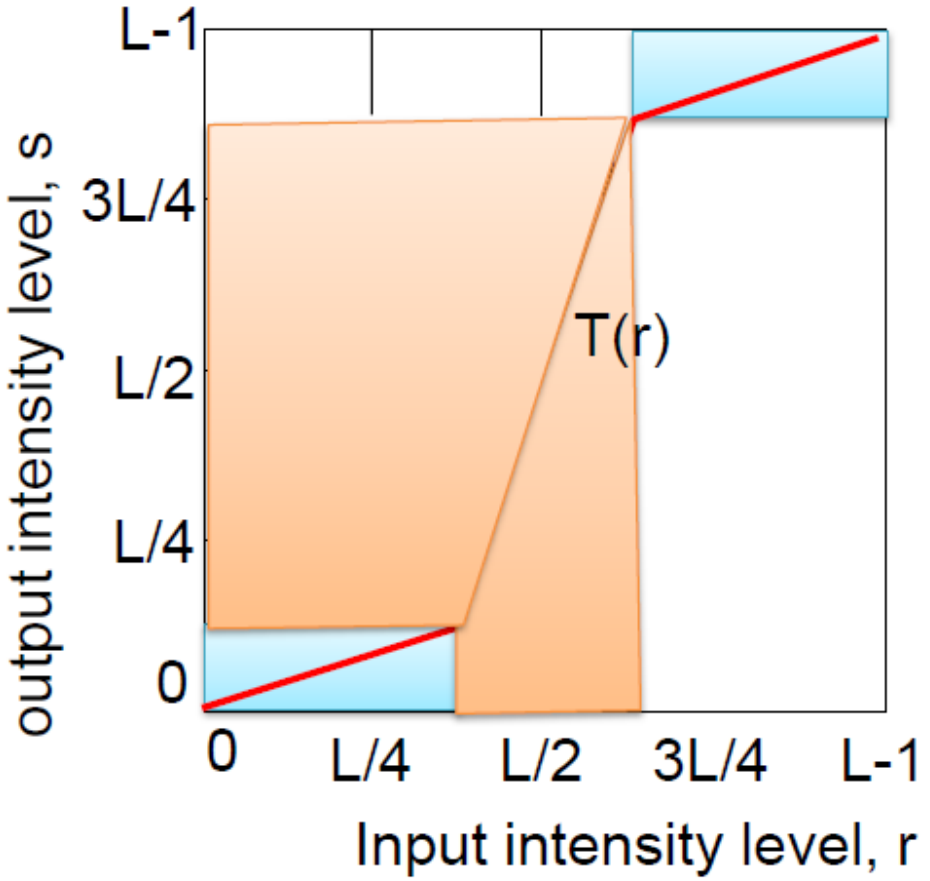
- Tujuan peregangan kontras: meningkatkan rentang nilai-nilai keabuan untuk citra kontras-rendah (terentang dari nilai r_1 sampai r_2 pada citra dengan nilai keabuan 0 sampai L – 1)



- Citra kontras-rendah dihasilkan dari
  – pencahayaan yang kurang
  – kekurangan pada rentang dinamis di dalam *imaging sensor*
  – kesalahan *setting* lensa selama akuisisi gambar

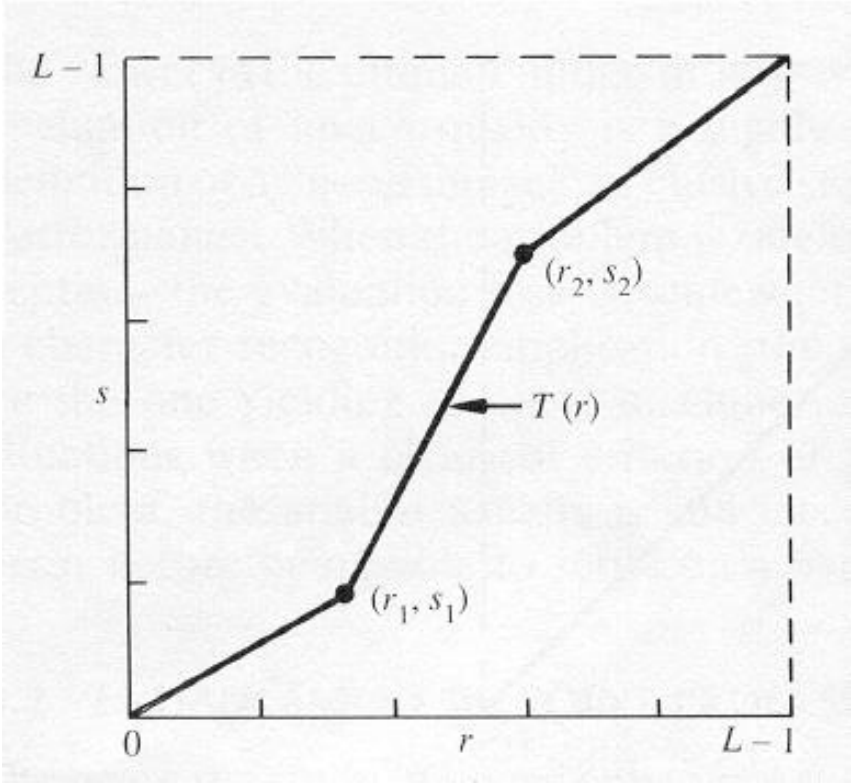
- Nilai-nilai pixel antara r_1 sampai r_2 akan dipetakan menjadi nilai antara s_1 sampai s_2

- Selang [r_1, r_2] yang sempit diregang menjadi selang [s_1, s_2] yang lebih lebar

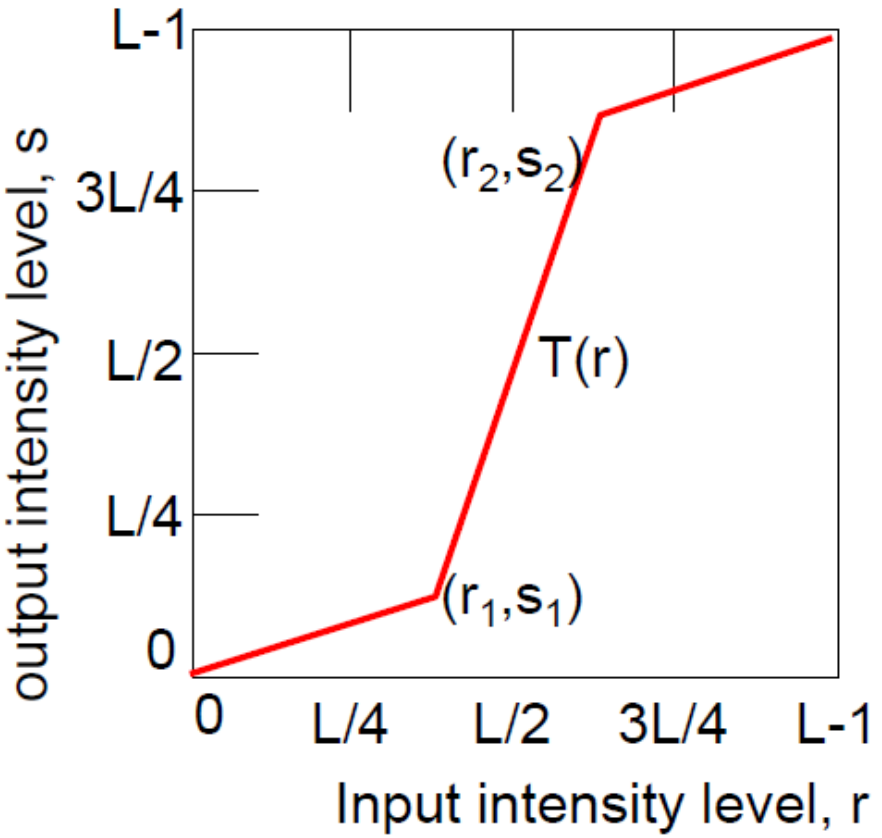


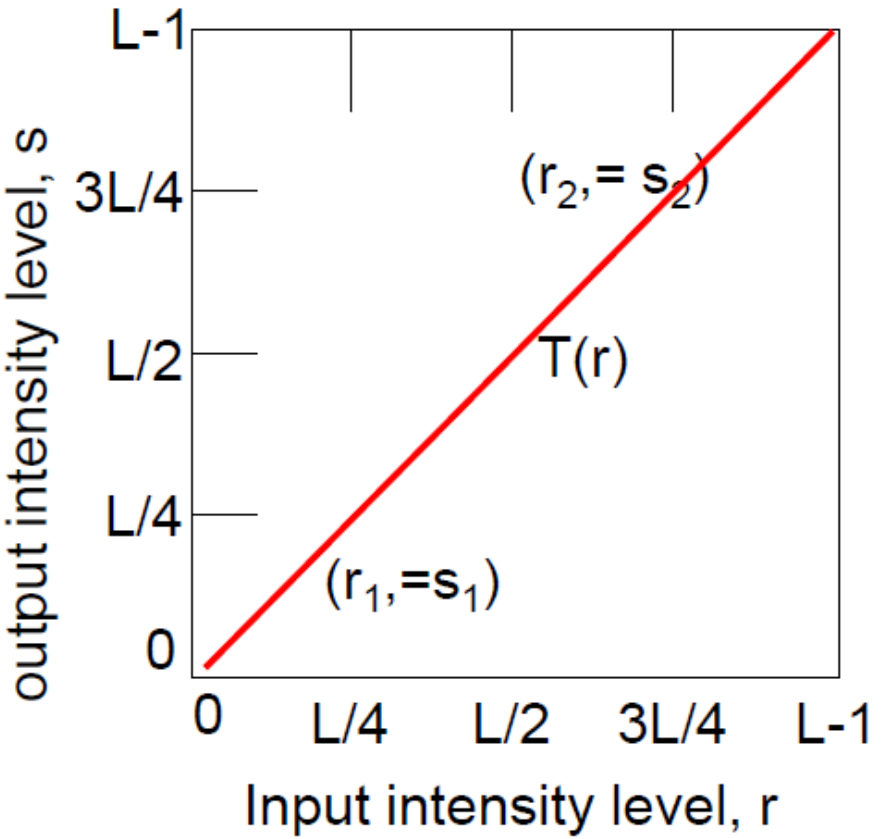
- Nilai-nilai di antara (r_1,s_1) and (r_2,s_2) menghasilkan penyebaran nilai keabuan citra luaran.

- Lokasi (r_1,s_1) dan (r_2,s_2) menentukan bentuk fungsi transformasi.
  - Jika r_1= s_1 dan r_2= s_2 maka transformasi adalah fungsi linier sehingga tidak menghasilkan perubahan.
  - Jika r_1=r_2, s_1=0 dan s_2=L-1, transformasi menjadi fungsi pengambangan yang menghasilkan citra biner.
  - Nilai-nilai di antara (r_1,s_1) and (r_2,s_2) menghasilkan penyebaran nilai keabuan citra luaran.
  - Umumnya diasumsikan $r_1 \leq r_2$ dan $s_1 \leq s_2$



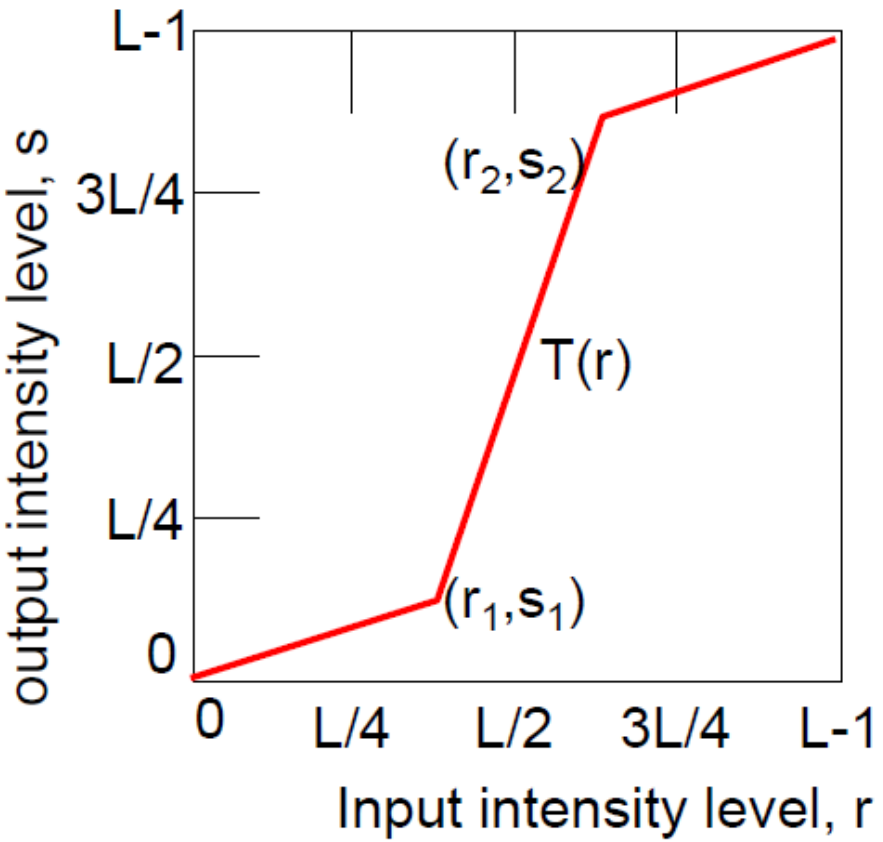
Jika $r_1 = s_1$ dan $r_2 = s_2$

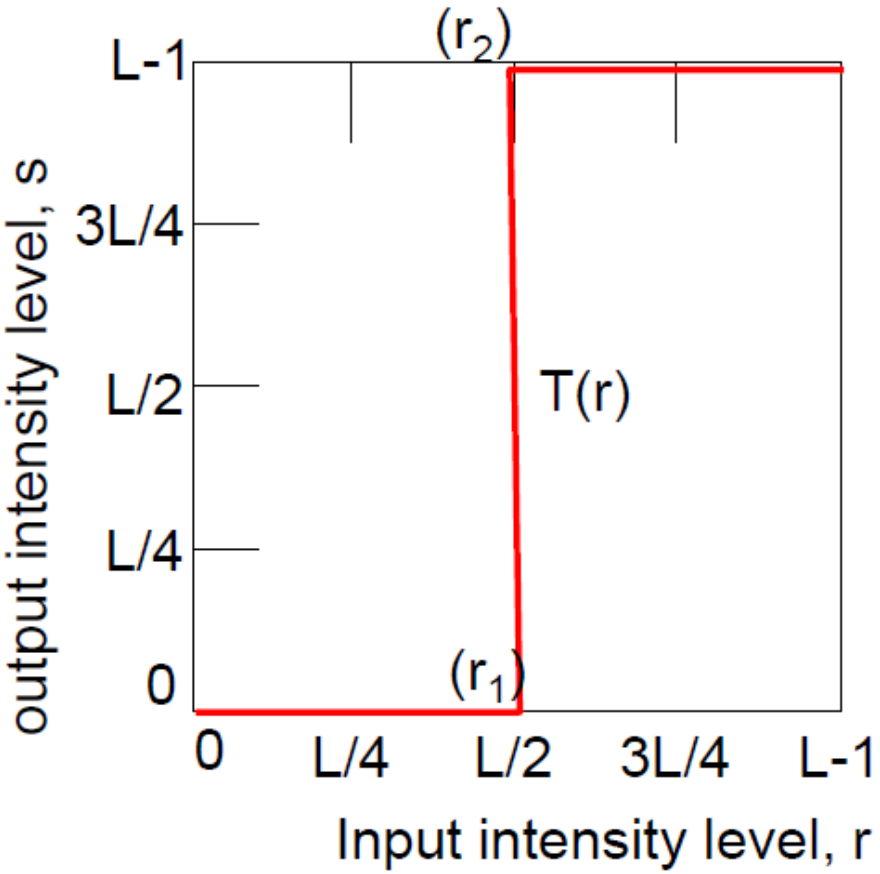




Sumber: Image Processing By Dr. Jagadish Nayak ,BITS Pilani, Dubai Campus

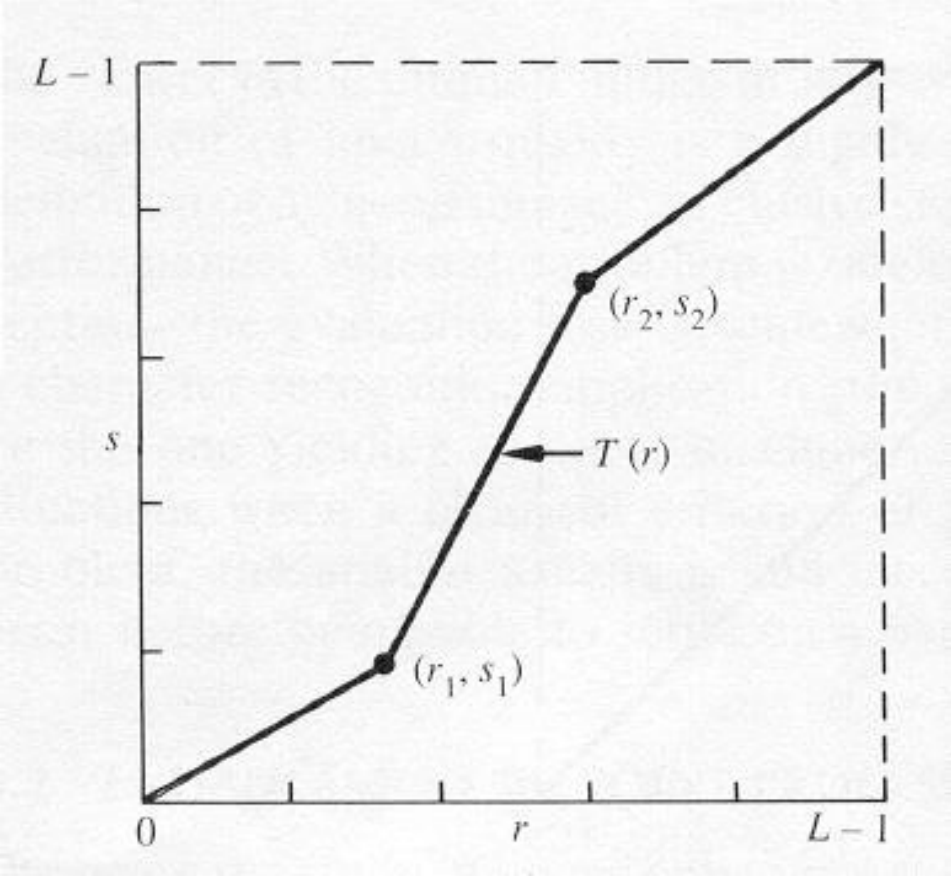
Jika $r_1=r_2$, $s_1=0$ dan $s_2=L-1$





Sumber: Image Processing By Dr. Jagadish Nayak ,BITS Pilani, Dubai Campus

- Bagaimana menentukan r_1 dan r_2?

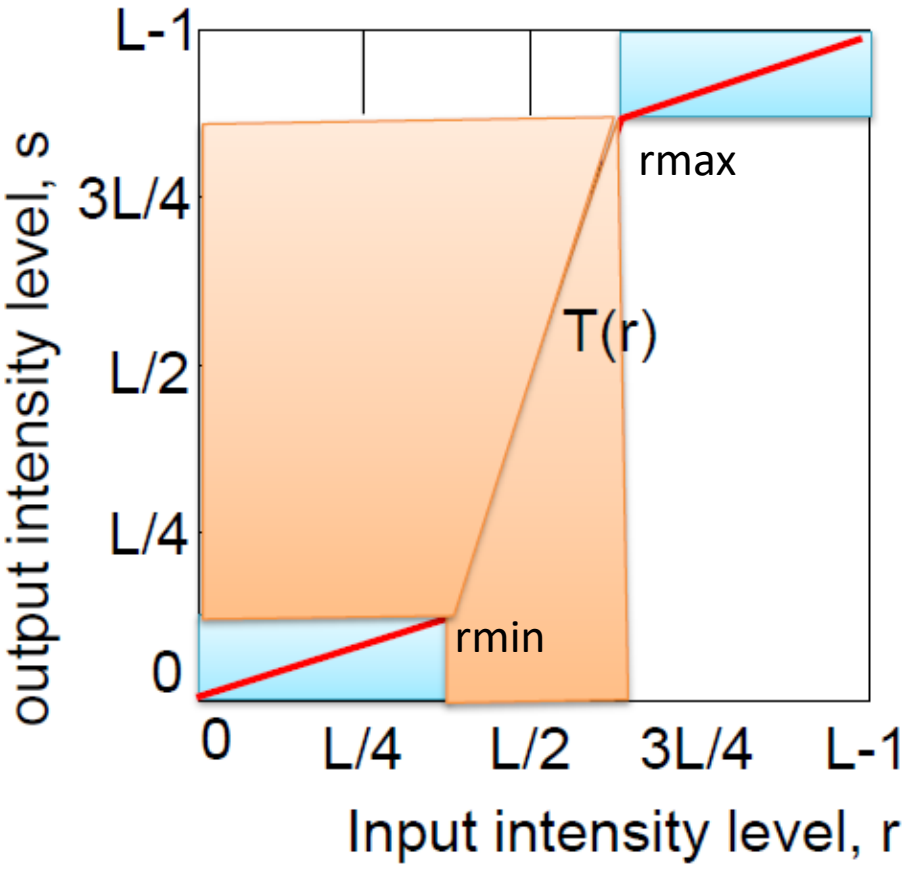


Salah satu pendekatan:

- pindai histogram citra, atau pindai pixel-pixel di dalam citra
- cari pixel bernilai minimum, misalkan *rmin*
- cari pixel bernilai maksimum, misalkan *rmax*
- pixel-pixel di bawah *rmin* diset 0
- Pixel-pixel di atas *rmax* diset L – 1
- r1 = *rmin*, r2 = *rmax*
- tentukan persamaan garis yang menghubungkan titik (*rmin*, 0) dan (*rmax*, L - 1) dengan persamaan umum garis lurus yang melalui titik (x1,y1) dan (x2,y2):

$$\frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$

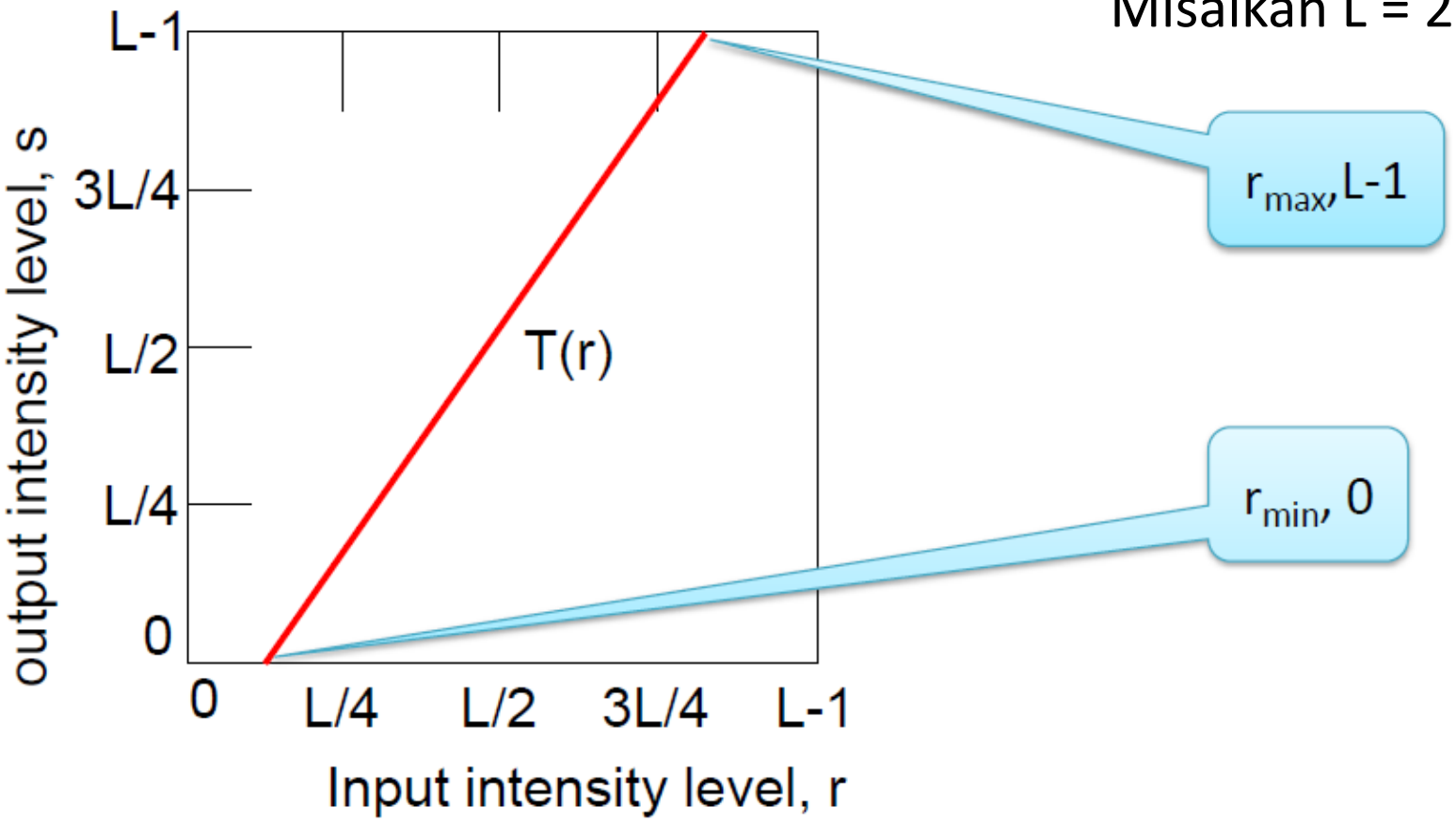
- Petakan nilai keabuan yang lain di antara (*rmin*, 0) dan (*rmax*, L - 1) dengan dengan menggunakan persamaan tersebut



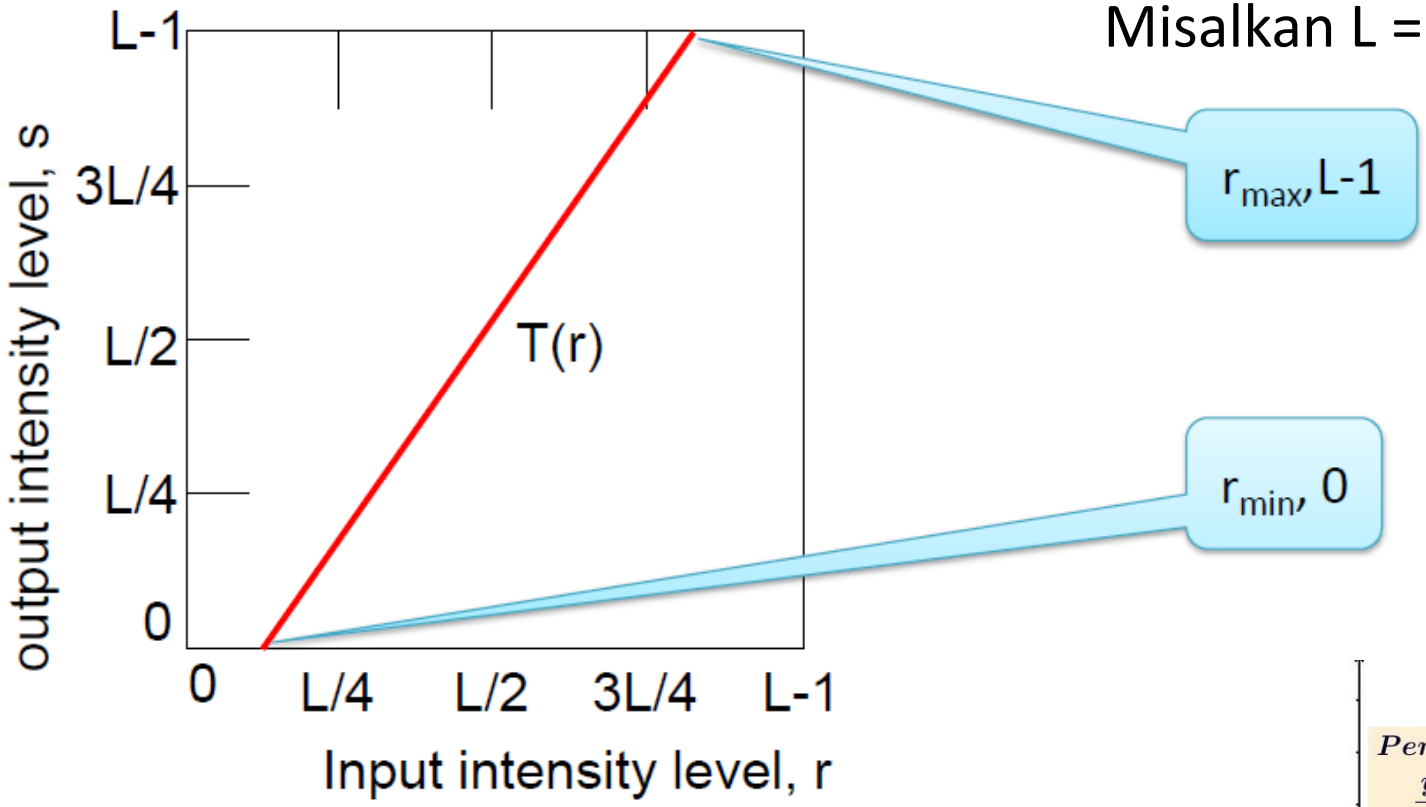
- pixel-pixel di bawah *rmin* diset 0
- Pixel-pixel di atas *rmax* diset L – 1

Contoh: $(r_1,s_1)=(r_{min}, 0)$ and $(r_2,s_2)=(r_{max},L-1)$

Misalkan L = 256



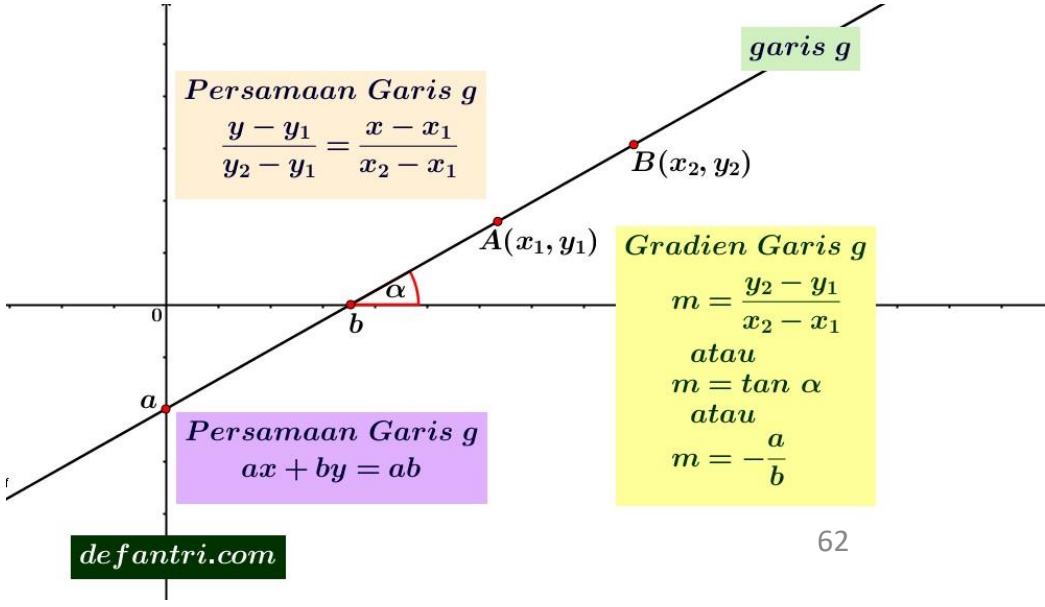
$(r_1,s_1)=(r_{min}, 0)$ and $(r_2,s_2)=(r_{max},L-1)$



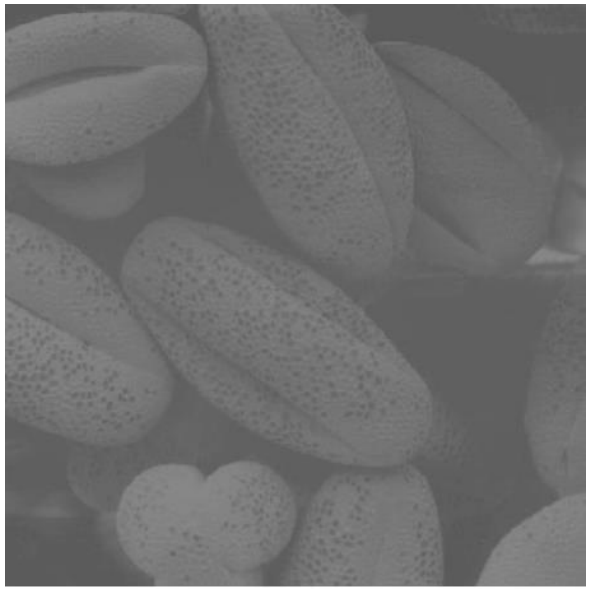
Misalkan L = 256

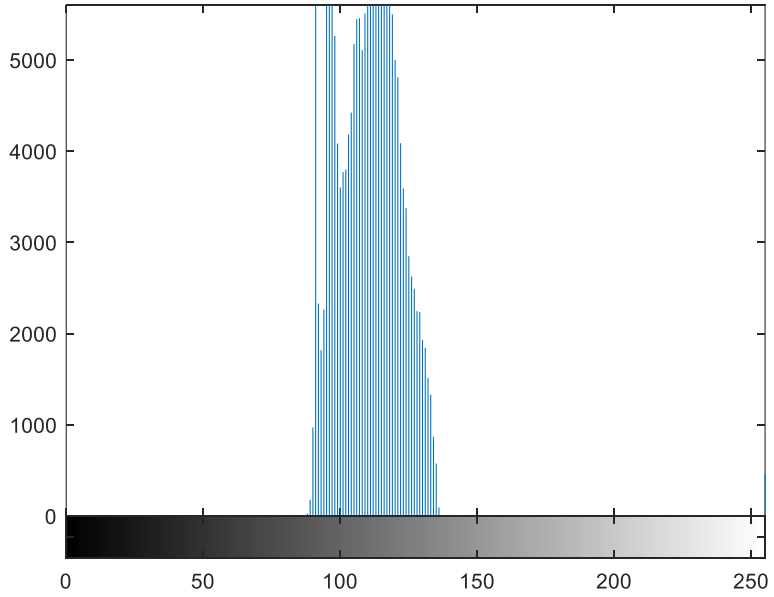
Persamaan garis yang melalui (*rmin*, 0) dan (*rmax*, 255):

$$\frac{s-0}{255-0} = \frac{r-rmin}{rmax-rmin} \rightarrow s = 255\frac{(r-rmin)}{(rmax-rmin)}$$

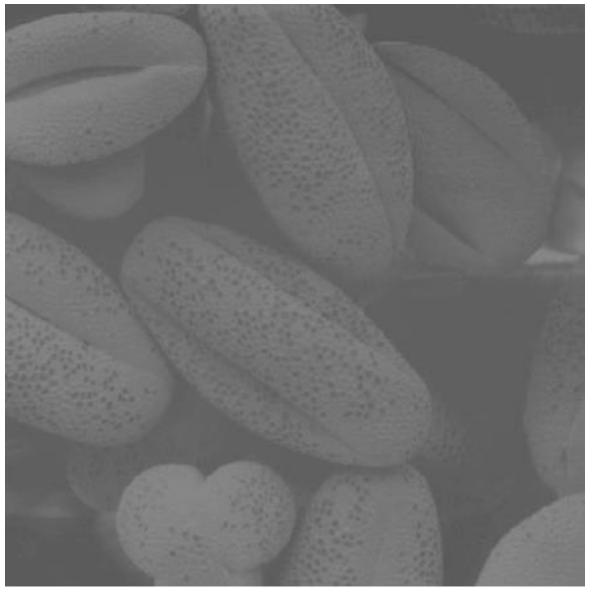


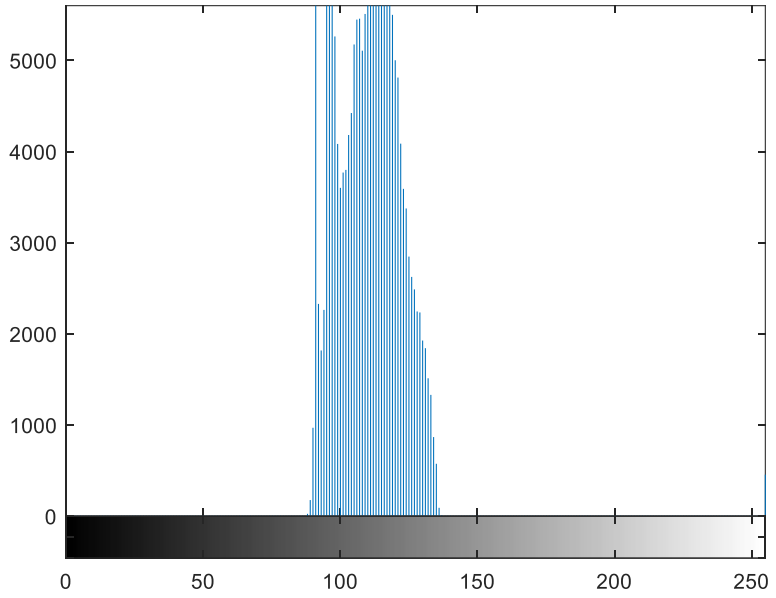
```
clear all;
clc;
I = imread('image1.bmp'); %read the image
rmin = 87;          % find the min. value of pixel in the image
rmax = 135;         % find the max. value of pixel in the image
I_new = (I - rmin).*(255/(rmax - rmin));   % transform the image
figure,imshow(I);          % display original image
figure,imhist(I);          % display histogram of original image
figure,imshow(I_new);      % display transformed image
figure,imhist(I_new);      % display histogram of transformed image
```





Sebelum

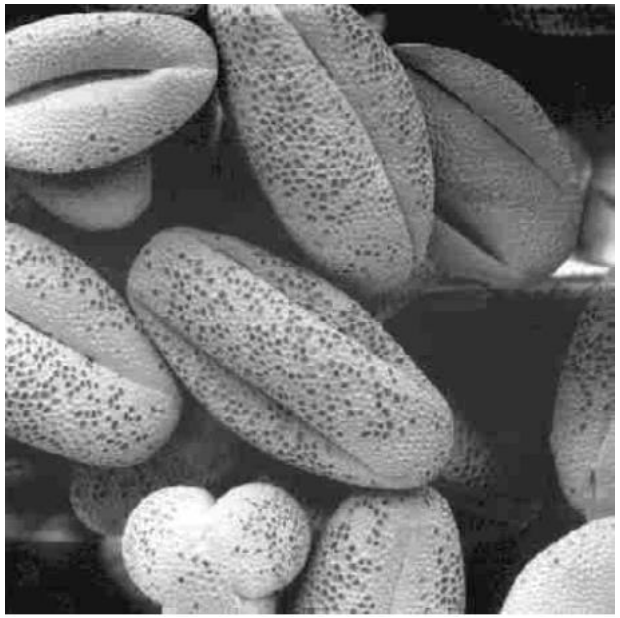


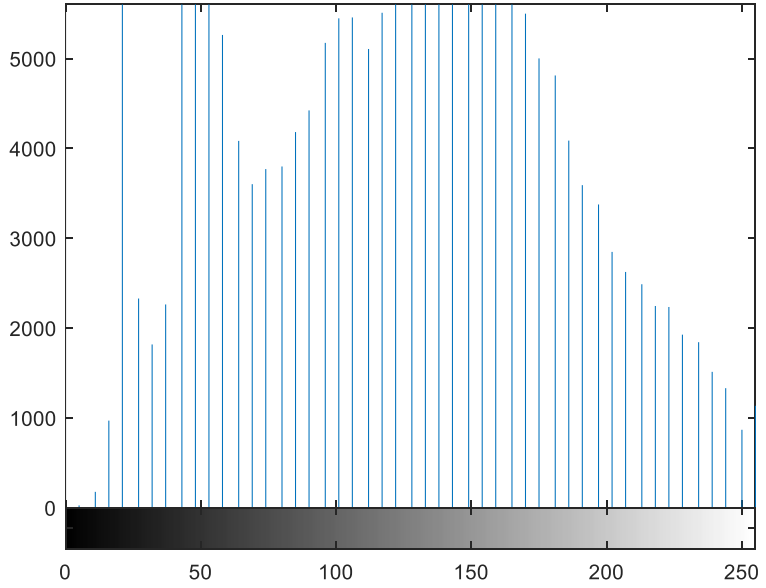


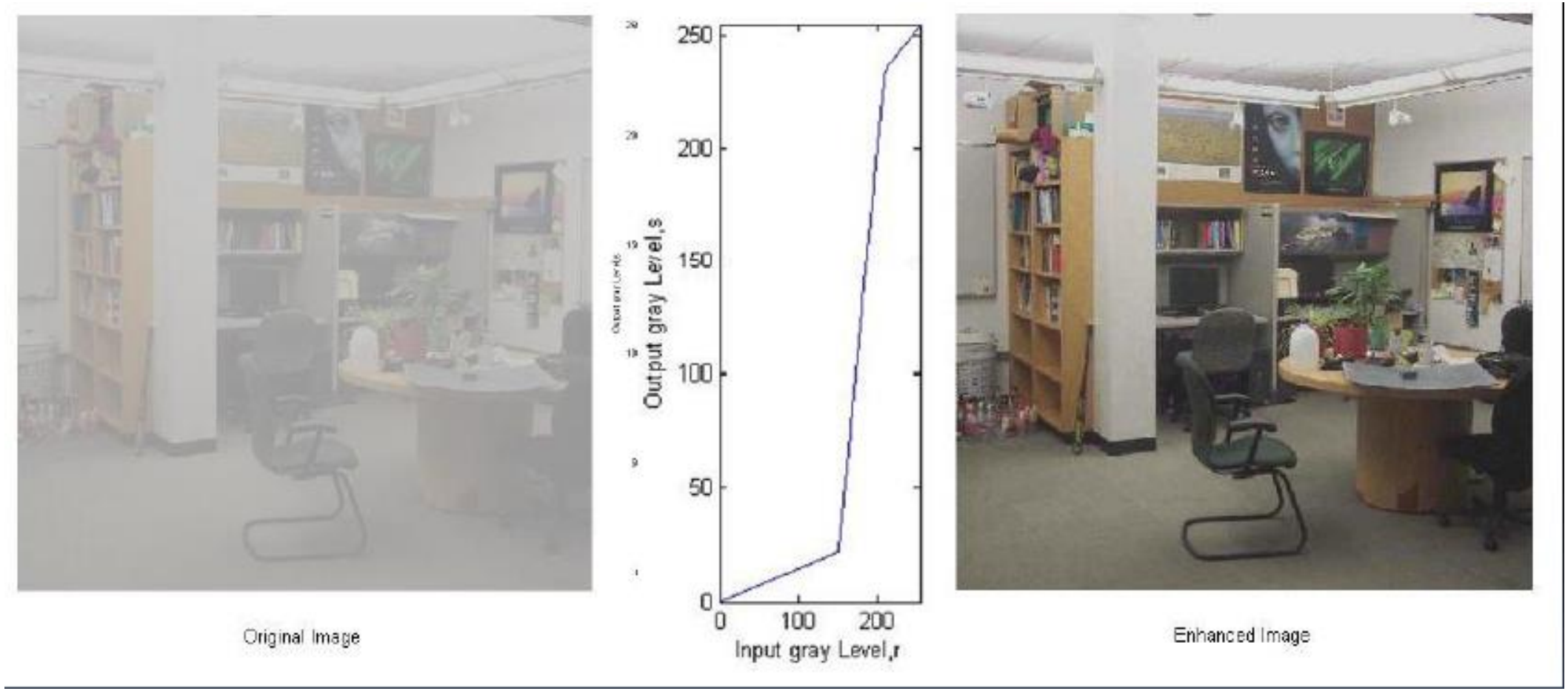
$r_{min} = 87$

$r_{max} = 135$

Sesudah



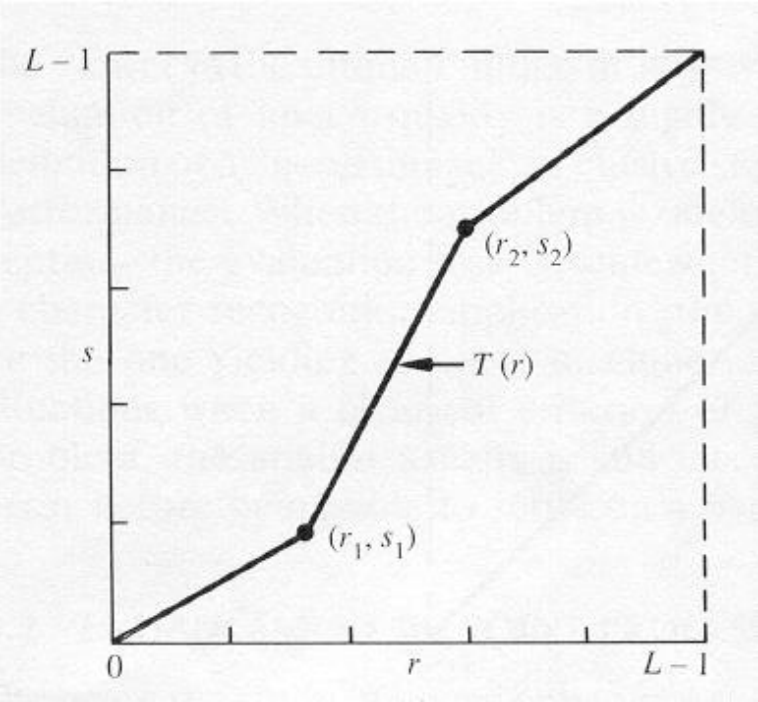




Sumber gambar: Ehsan Khoramshahi,
Image enhancement in spatial domain

Piece-wise linier transformation function

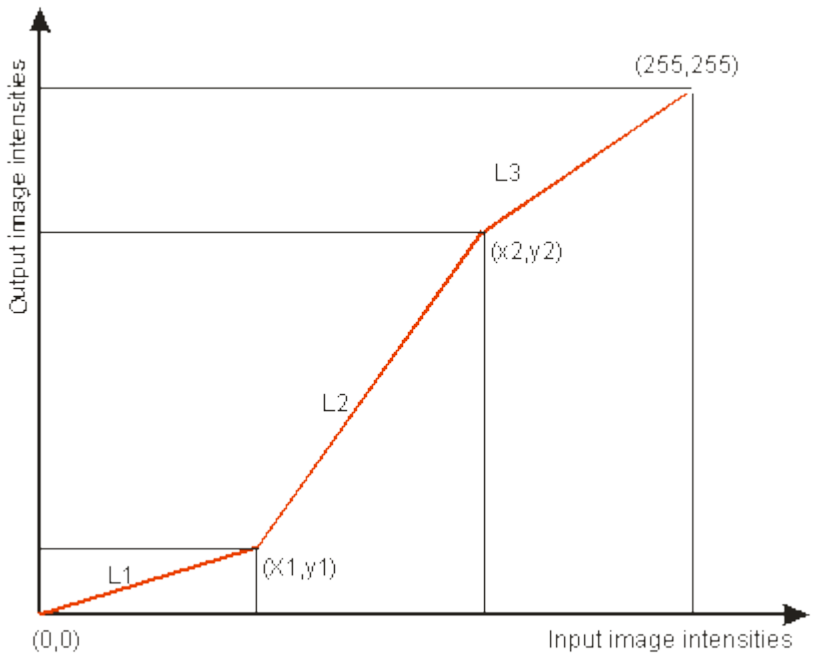
- Peregangan kontras termasuk ke dalam fungsi transformasi sepotong-sepotong (*piece-wise linier transformation function*)



Fungsi transformasi linier sepotong-sepotong:

1. *Contrast stretching*
2. *Gray-level slicing*
3. *Bit-plane slicing*

- Alternatif lain fungsi transformasi sepotong-sepotong:



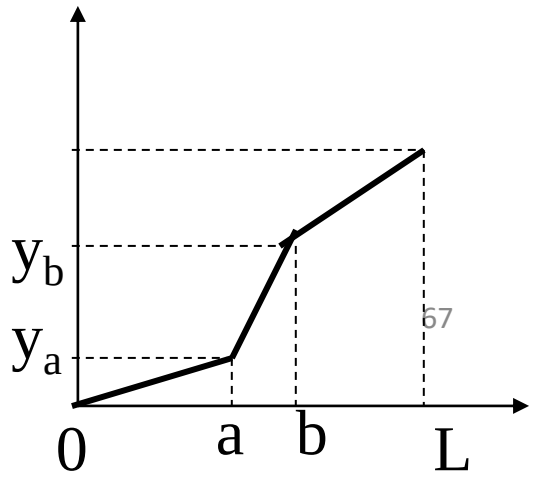
$$y = \begin{cases} \dfrac{y1}{x1}x, & 0 \le x \le x1 \\ \dfrac{y2-y1}{x2-x1}x + y1, & x1 < x < x2 \\ \dfrac{255-y2}{255-x2}x + y2, & x2 < x < 255 \end{cases}$$

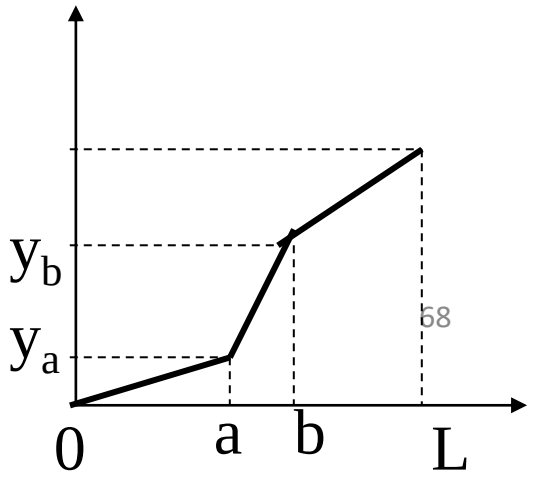
$$y = \begin{cases} \alpha x & 0 \le x < a \\ \beta(x-a)+y_a & a \le x < b \\ \gamma(x-b)+y_b & b \le x < L \end{cases}$$

Persamaan garis L1: $y = \frac{y1}{x1}x$

Persamaan garis L2: $y = \frac{y2-y1}{x2-x1}.x + y1$

Persamaan garis L3: $y = \frac{255-y2}{255-x2}.x + y2$





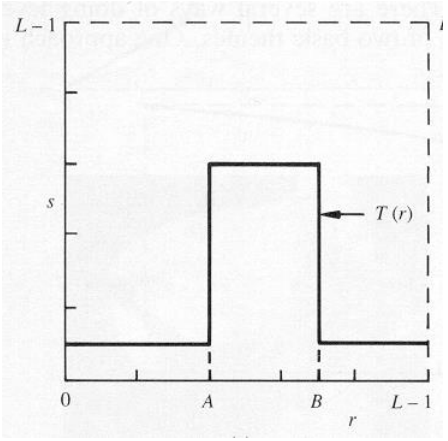
$$a = 50, b = 150, \alpha = 0.2, \beta = 2, \gamma = 1, y_a = 30, y_b = 200$$

$$y = \begin{cases} \alpha x & 0 \le x < a \\ \beta(x-a) + y_a & a \le x < b \\ \gamma(x-b) + y_b & b \le x < L \end{cases}$$

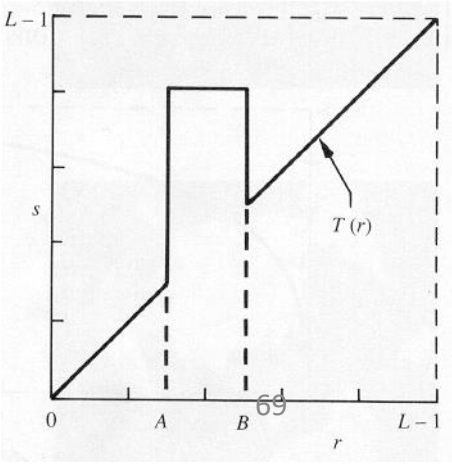
4. Gray-level Slicing

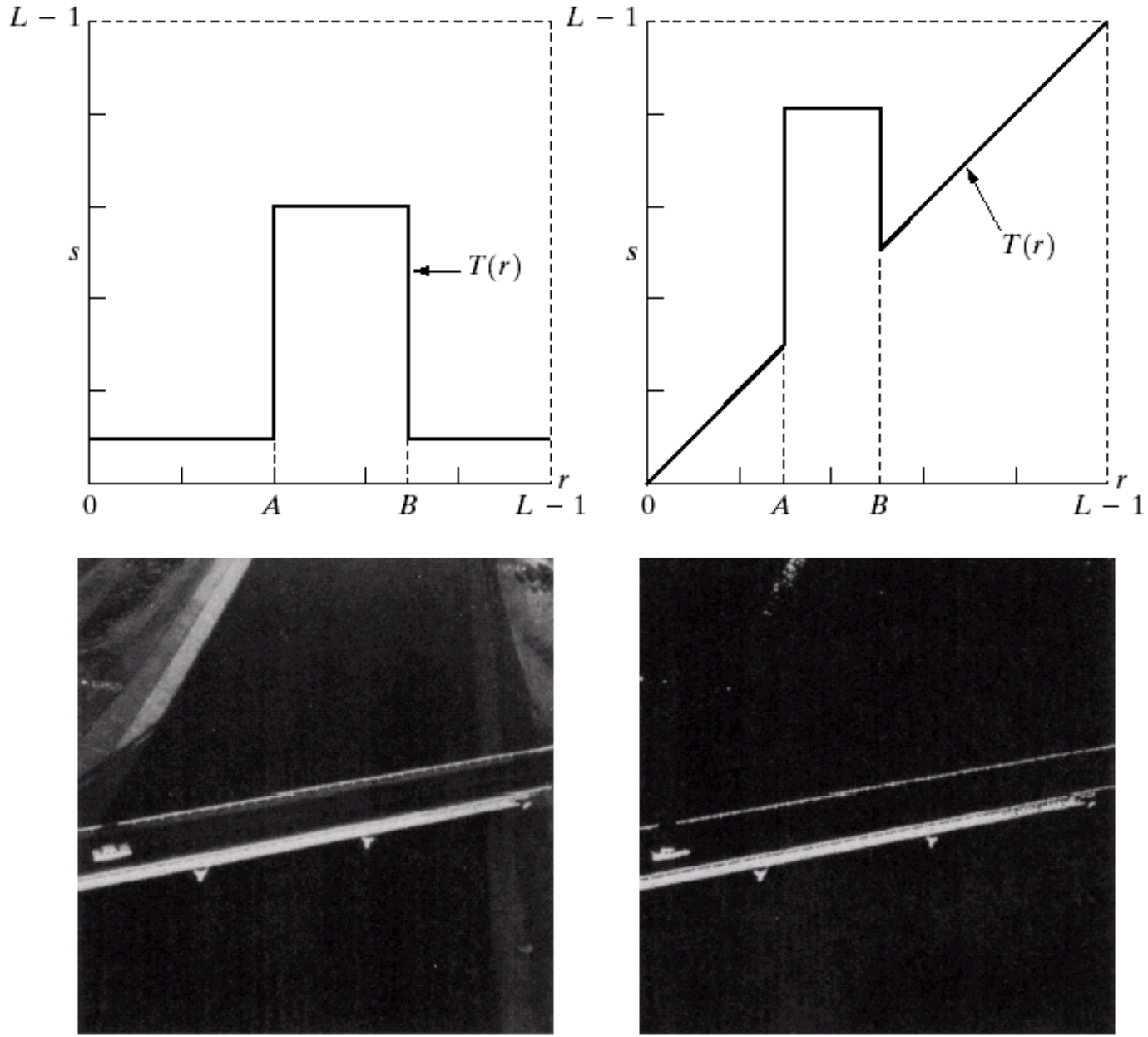
- Tujuan: menonjolkan (*highlight*) rentang keabuan tertentu di dalam citra.
- Contoh: menonjolkan gumpalan air yang ada pada citra satelit, menonjolkan cacat yang ada pada citra sinar X.
- Dua pendekatan di dalam *graylevel slicing*:

1. Menampilkan lebih terang semua *graylevel* di dalam rentang yang ingin ditonjolkan, dan menampilkan lebih gelap semua *graylevel* lainnya (‘*discard background*’).



2. Menampilkan lebih terang semua *graylevel* di dalam rentang yang ingin ditonjolkan, sembari tetap mempertahankan *graylevel* lainnya (‘*preserve background*’)





a b
c d

FIGURE 3.11
(a) This transformation highlights range $[A, B]$ of gray levels and reduces all others to a constant level. (b) This transformation highlights range $[A, B]$ but preserves all other levels. (c) An image. (d) Result of using the transformation in (a).

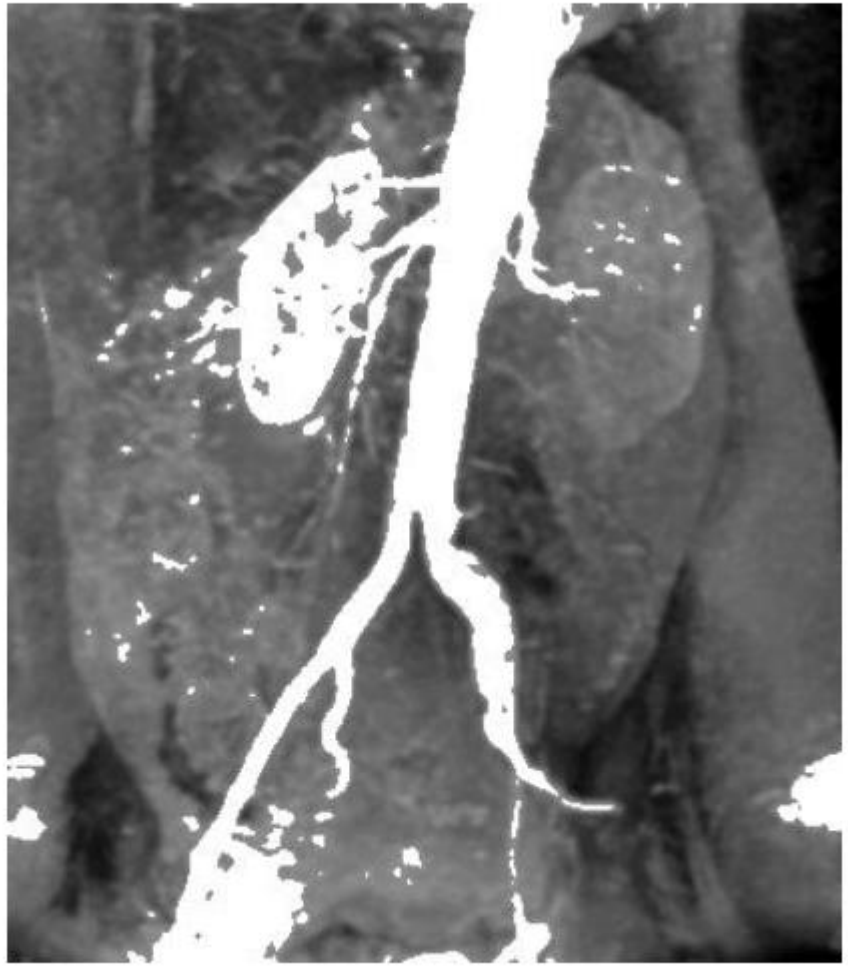
Preserve Background

```
clear all ;
clc;
im = imread'kidney.tif');
z=double(im);
[row,col]=size(z);
for i=1:1:row
   for j=1:1:col
        if ((z(i,j)>142)) && (z(i,j)<250)
           z(i,j)=255;
        else
           z(i,j)=im(i,j);
        end
   end
end
figure(1); %-----------Original Image-------------%
imshow(im);
figure(2); %-----------Gray Level Slicing With Background-------------%
imshow(uint8(z));
```

Sumber: Image Processing By Dr. Jagadish Nayak ,BITS Pilani, Dubai Campus

Preserve Background

Intensity Level slicing (Example)



Sumber: Image Processing By Dr. Jagadish Nayak ,BITS Pilani, Dubai Campus

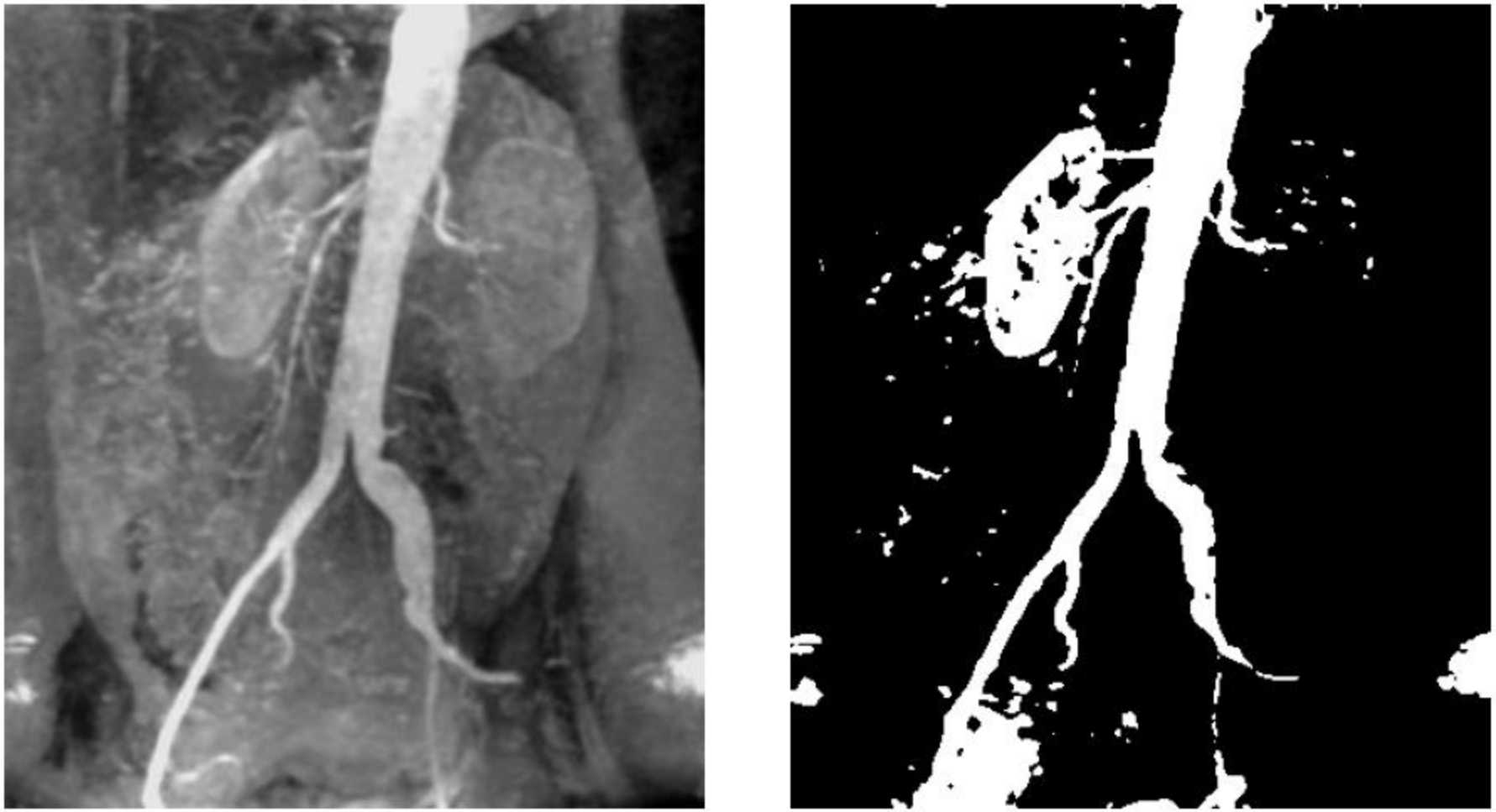
Discard Background

```
clear all ;
clc;
im = imread'kidney.tif');
z=double(im);
[row,col]=size(z);
for i=1:1:row
   for j=1:1:col
        if ((z(i,j)>142)) && (z(i,j)<250)
           z(i,j)=255;
        else
           z(i,j)=0;
        end
   end
end
figure(1); %-----------Original Image-------------%
imshow(im);
figure(2); %-----------Gray Level Slicing With Background-------------%
imshow(uint8(z));
```

Sumber: Image Processing By Dr. Jagadish Nayak ,BITS Pilani, Dubai Campus

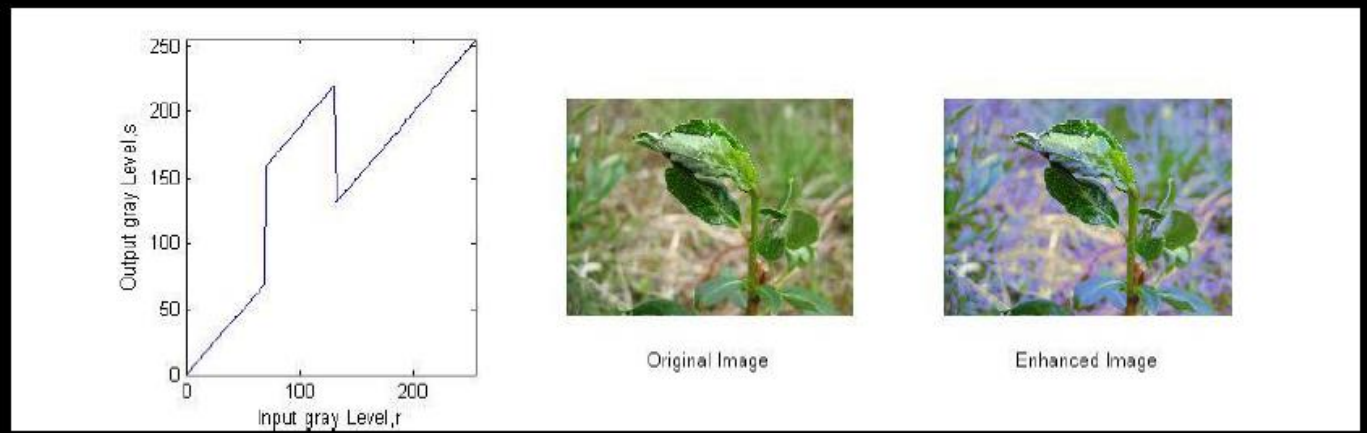
Discard Background

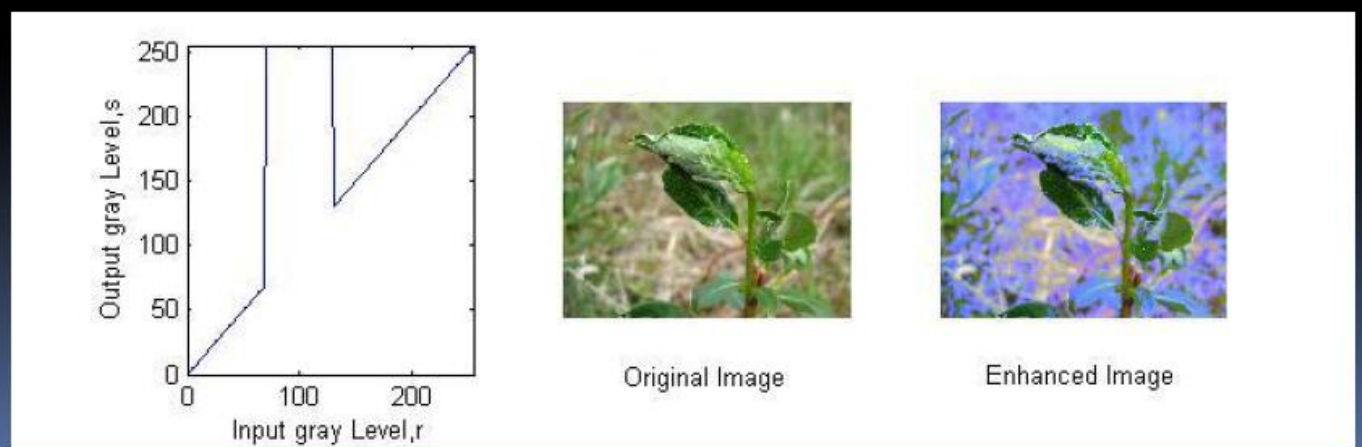
Intensity Level slicing (Example)



Sumber: Image Processing By Dr. Jagadish Nayak ,BITS Pilani, Dubai Campus

Slicing Example





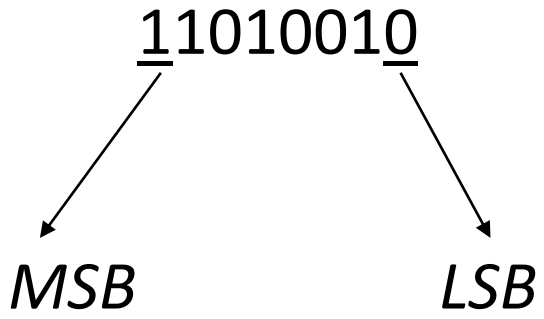
Sumber gambar: Ehsan Khoramshahi, *Image enhancement in spatial domain*

5. Bit-plane Slicing

- Tujuan: Menonjolkan kontribusi dari bit tertentu di dalam citra.
- Misalkan satu pixel = 8 bit. Bit-bit tersusun dari kiri ke kanan dalam urutan yang kurang berarti (*least significant bits* atau *LSB*) hingga bit-bit yang berarti (*most significant bits* atau *MSB*).

- Susunan bit pada setiap *byte* adalah $b_7b_6b_5b_4b_3b_2b_1b_0$.

  Contoh:



- Jika setiap bit dari setiap *pixel* diambil, maka diperoleh 8 buah bidang (*bit-plane*).

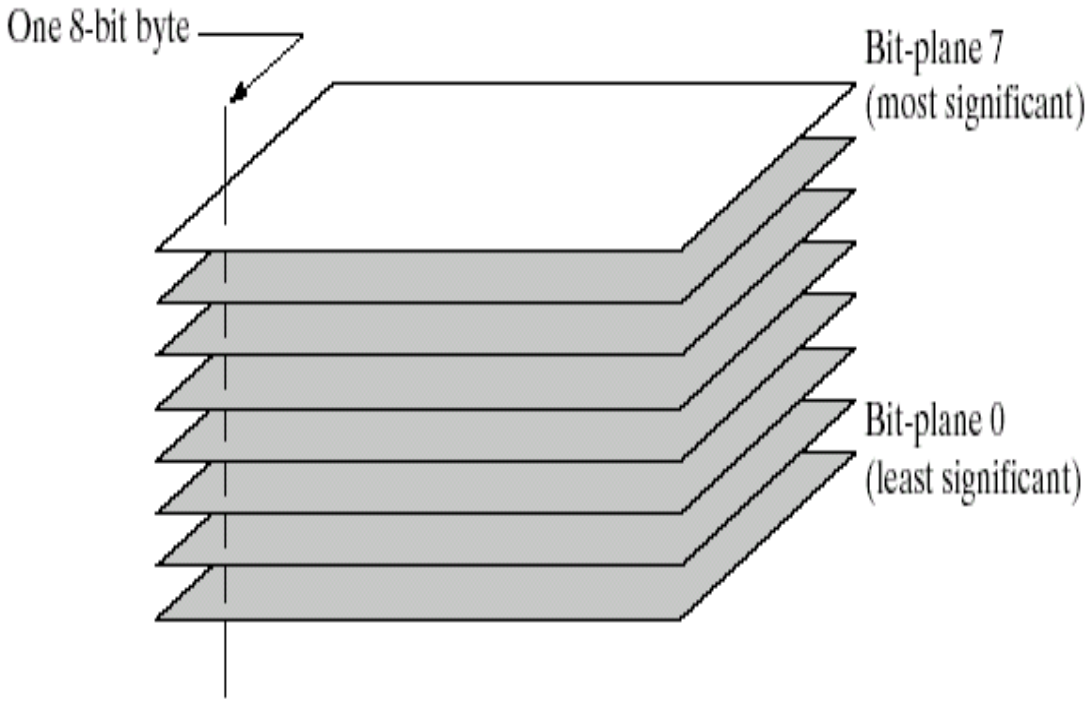


FIGURE 3.12
Bit-plane representation of an 8-bit image.

```
I = imread('cameraman.bmp');
imshow(I);
s = size(I);
for i=1:s(1)
    for j=1:s(2)
        for k=1:8
            P(i,j,k) = bitget(I(i,j), k);
        end
    end
end

P = logical(P);
for k=1:8
    figure,imshow(P(:,:,k))
end
```

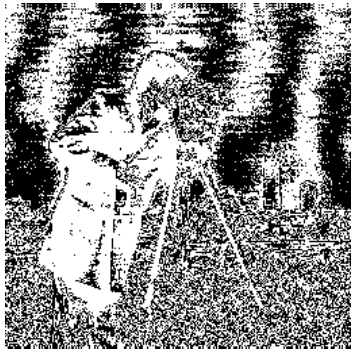
Original image

Bitplane 7

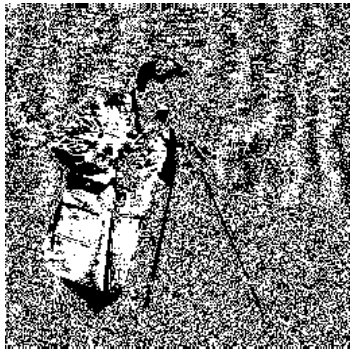
Bitplane 6

Bitplane 5

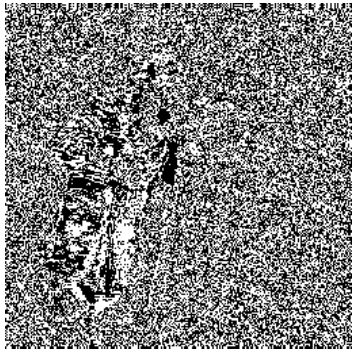
Bitplane 4



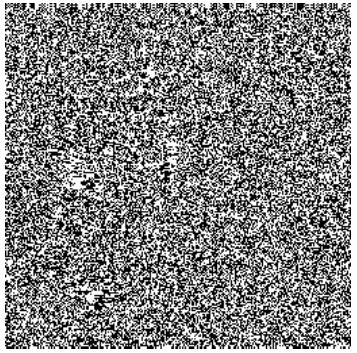
Bitplane 3



Bitplane 2



Bitplane 1



Bitplane 0

Contoh:

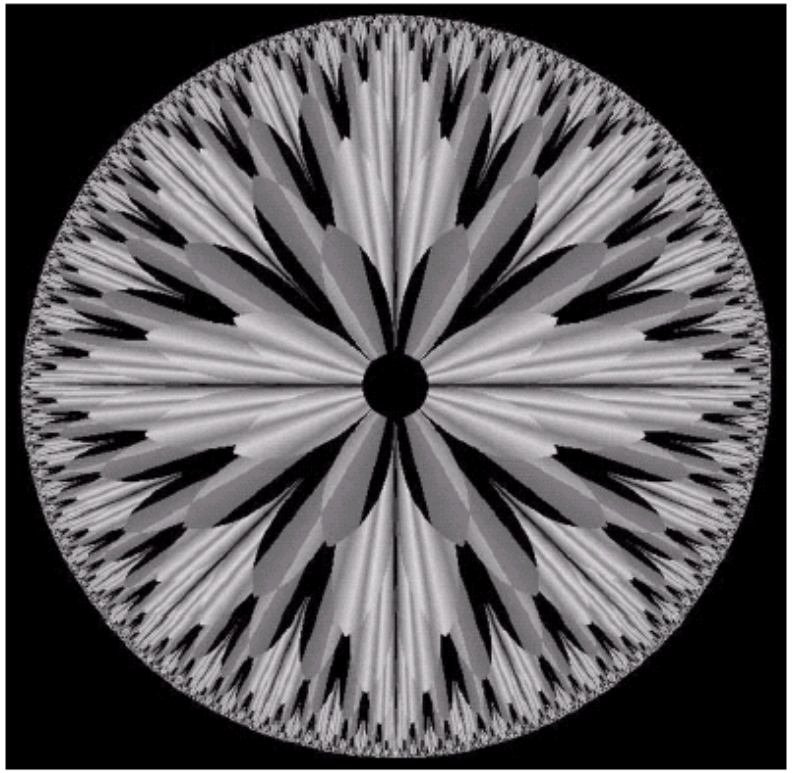


FIGURE 3.13 An 8-bit fractal image. (A fractal is an image generated from mathematical expressions). (Courtesy of Ms. Melissa D. Binde, Swarthmore College, Swarthmore, PA.)

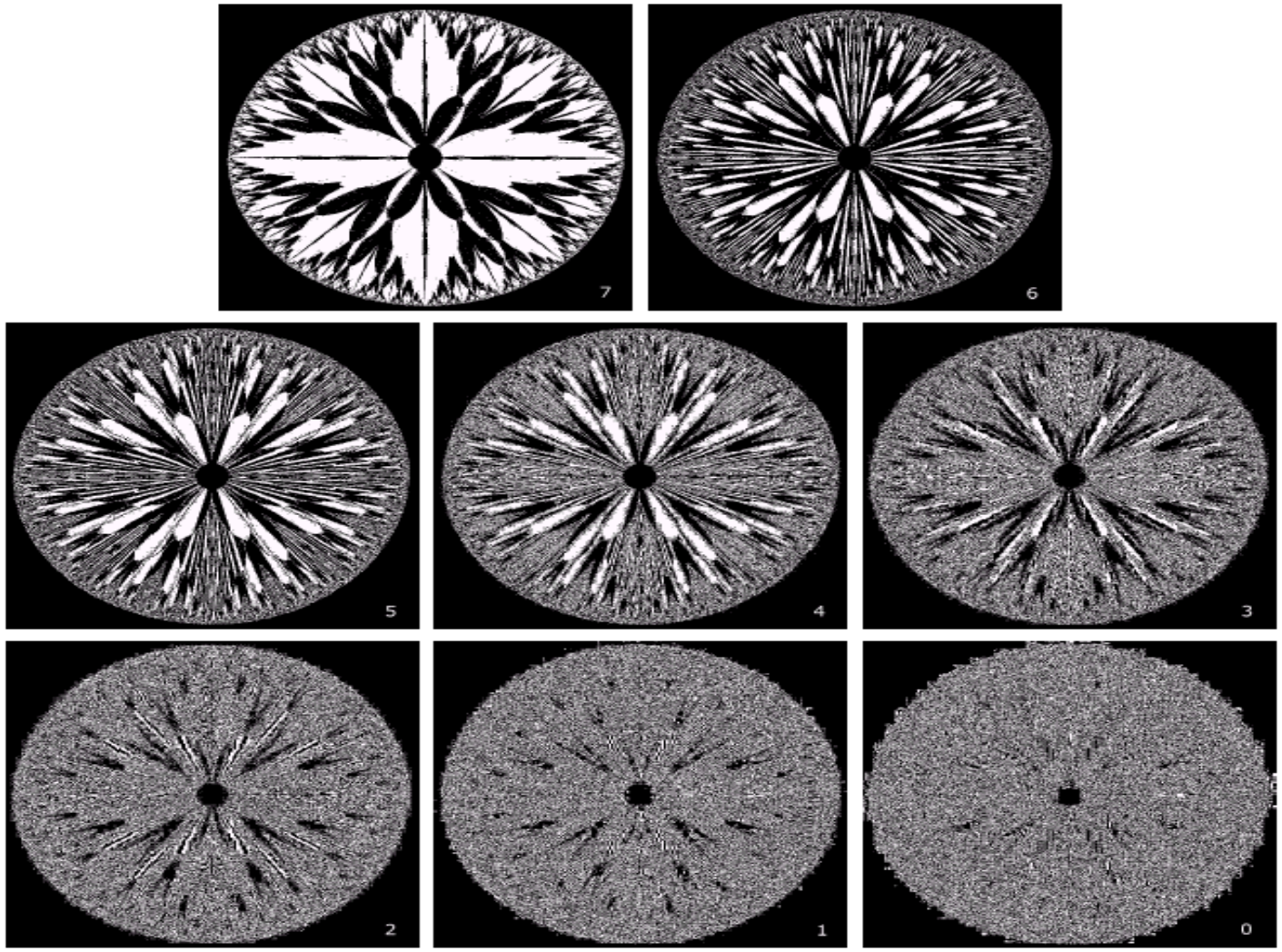


FIGURE 3.14 The eight bit planes of the image in Fig. 3.13. The number at the bottom, right of each image identifies the bit plane.

Bit-plane 7	Bit-plane 6	
Bit-plane 5	Bit-plane 4	Bit-plane 3
Bit-plane 2	Bit-plane 1	Bit-plane 0