

Pengolahan Citra dan Visi Komputer

Digital Image and Computer Vision

RTI196006

#02 – Dasar DIP, Format Citra, Warna

Team Teaching PCVK 2021/2022

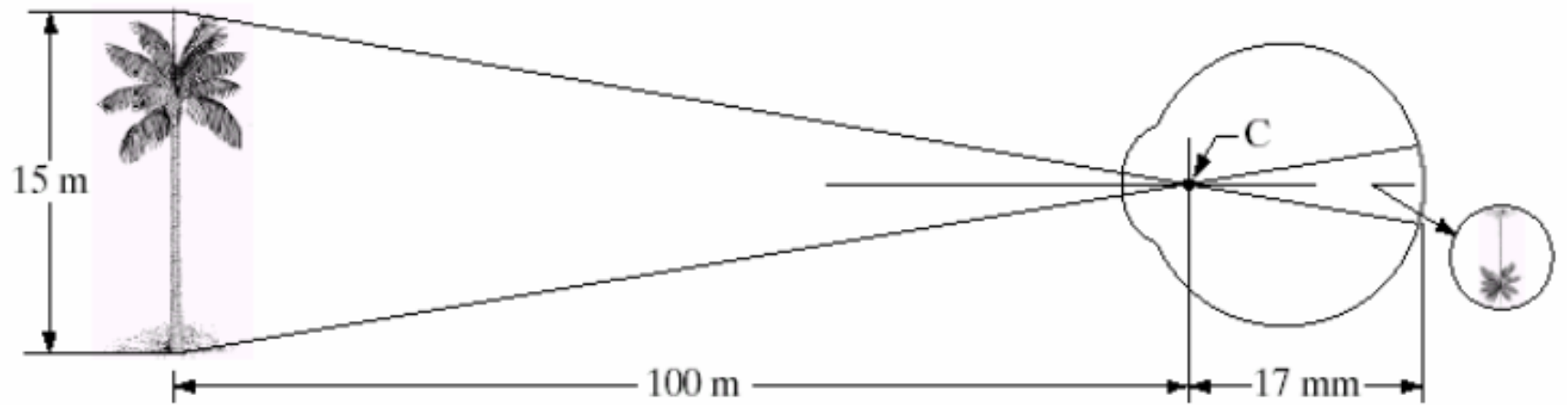
23-02-2022

Materi

- Cara kerja mata
- Model Kamera
- Sampling dan Kuantisasi
- Jenis-jenis Citra
- Model Citra Berwarna
- Format Warna RGB
- Membaca dan menampilkan citra

FIGURE 2.3

Graphical representation of the eye looking at a palm tree. Point *C* is the optical center of the lens.



$$15/100 = h/17$$
$$H=2.55\text{mm}$$

Image

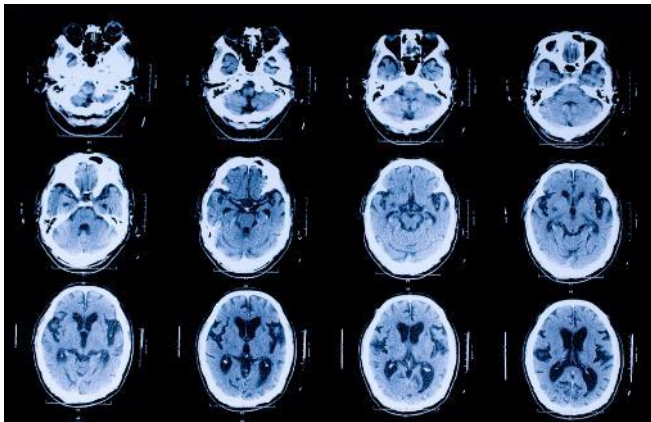
- a physical likeness or representation of a person, animal, or thing, photographed, painted, sculptured, or otherwise made visible.

representasi dari manusia, hewan, benda dll.



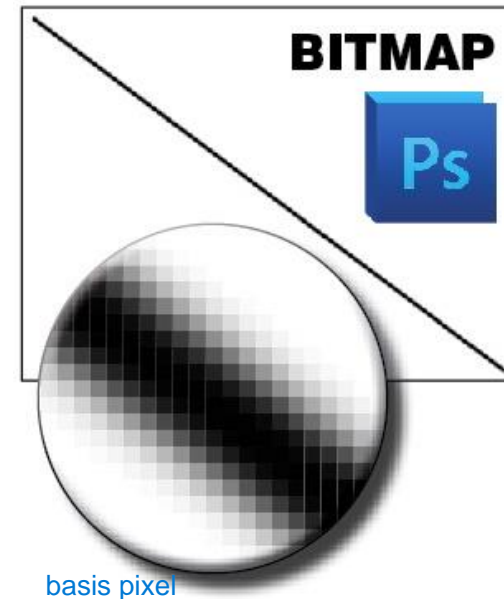
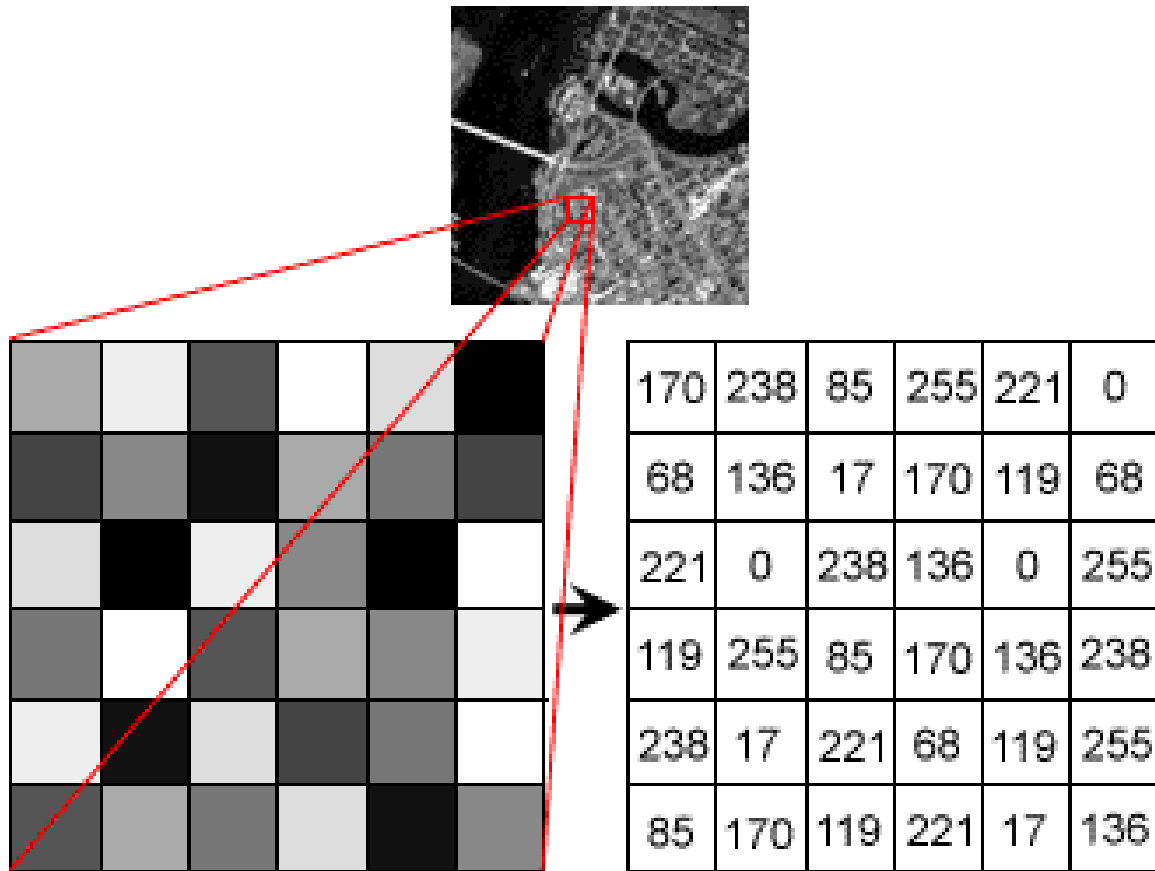
Analog Image

- an image that is continuous, like a picture on a TV monitor, x-rays, the photos are printed on paper, paintings, landscapes, CT scans and so forth.
- can not be presented in a computer that can not be processed in the computer directly.
tidak dapat disajikan di komputer yang tidak dapat diproses di komputer secara langsung.
- generated from analog devices include an analog video camera, analog photo camera, CT scan, etc.



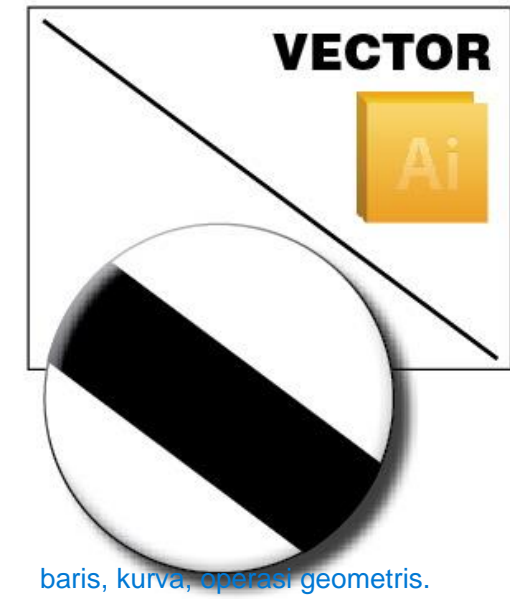
Digital image

- Image that can be processed with computer
 - Bitmap
 - Vector



basis pixel
Zoom in: Photoshop minimises the jagged staircase effect by softening the edges of the line with blended pixels in a process known as antialiasing. The higher the resolution of the file, the better the image will look - aliasing (staircase effect) will be minimised.

Large prints require large images and/or large resolutions. Colour images for printing presses are typically created at 300 ppi at actual size.

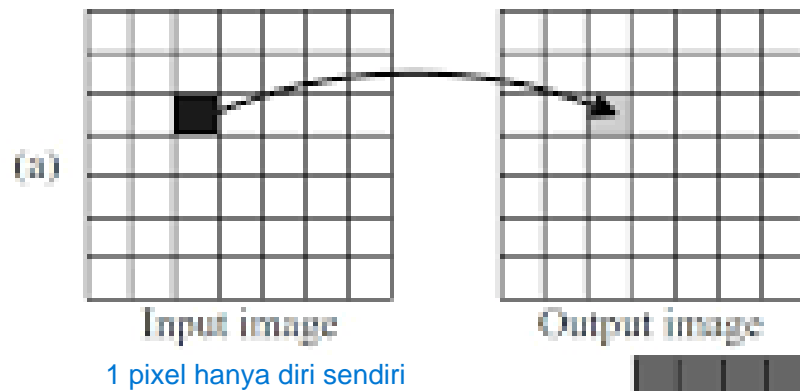


baris, kurva, operasi geometris.
Zoom in: Because vector art is mathematically calculated and pixel independent, no matter how much you zoom in or enlarge the image, the edges remain as sharp as the viewing screen (or printer) will allow.

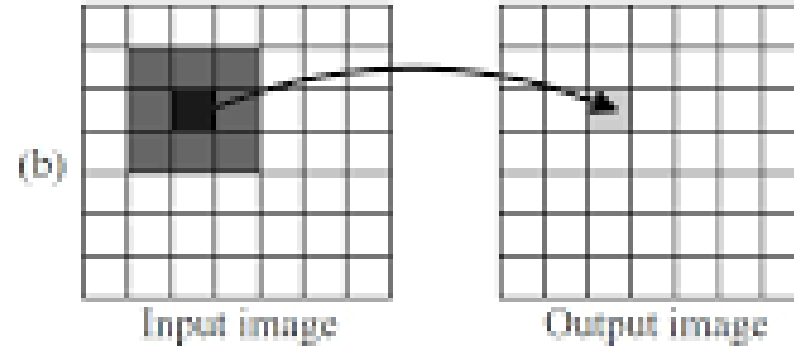
Although you will be looking at a bitmap pixel-based display on the computer screen, internally, Illustrator keeps track of its graphics as vectors.

Image operation

(a) Point Operation
Global Operation



(b) Area Operation



(c) global operation

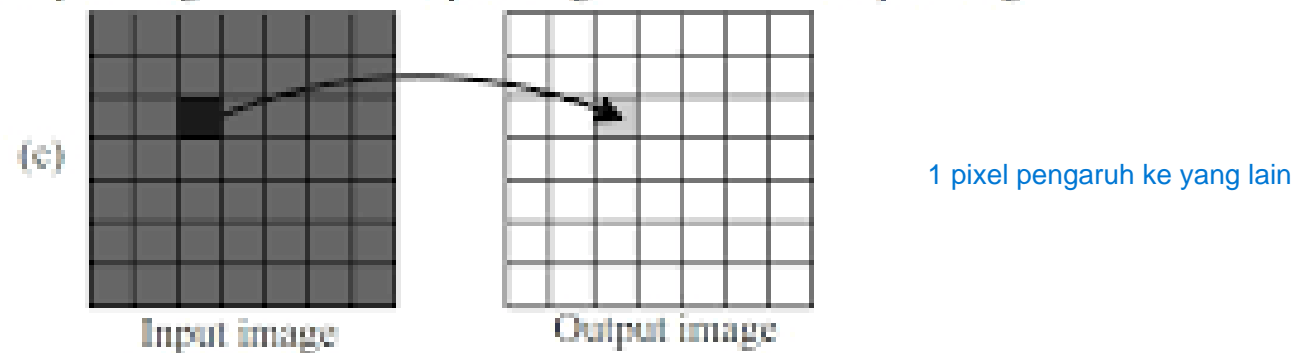
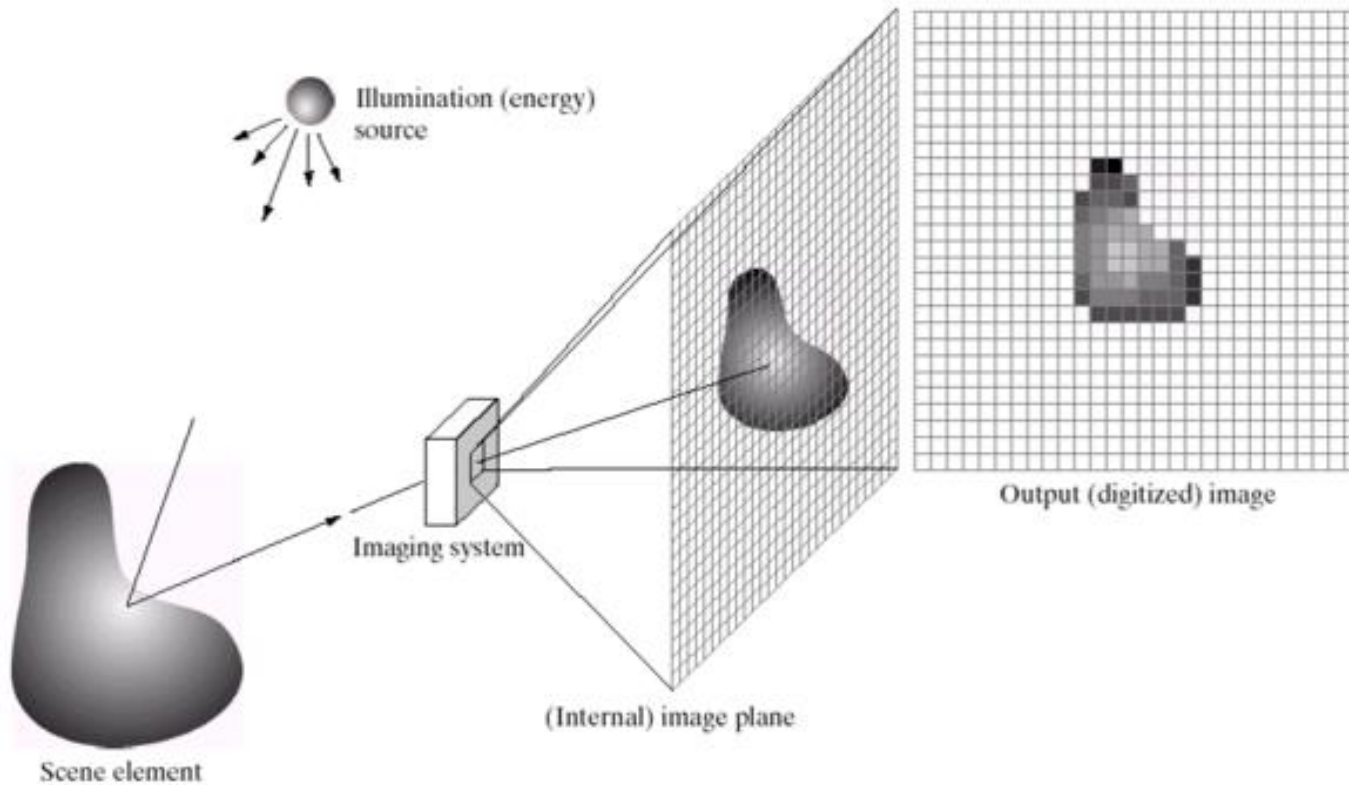


Image acquisition



a b c d e

FIGURE 2.15 An example of the digital image acquisition process. (a) Energy (“illumination”) source, (b) An element of a scene, (c) Imaging system, (d) Projection of the scene onto the image plane, (e) Digitized image.

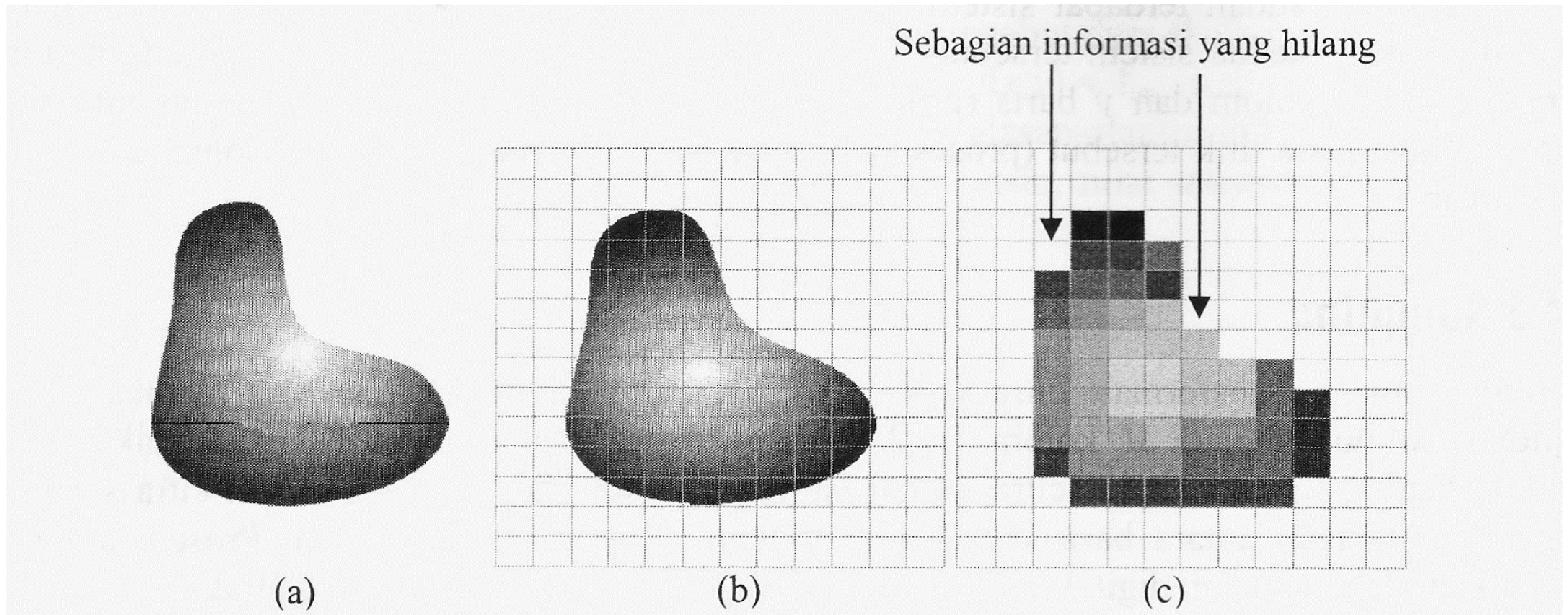
Process to Acquire Digital Image

Illumination source →
Scene Element →
reflected light → Sensor
in Imaging system →
Image Plane → Electrical
current → Digital data
converter → digitized
Image

Image digitalization

- Sampling sample
- Quantizing kuantitas
- Resolution resolusi

Sampling



Sistem koordinat citra berukuran $M \times N$

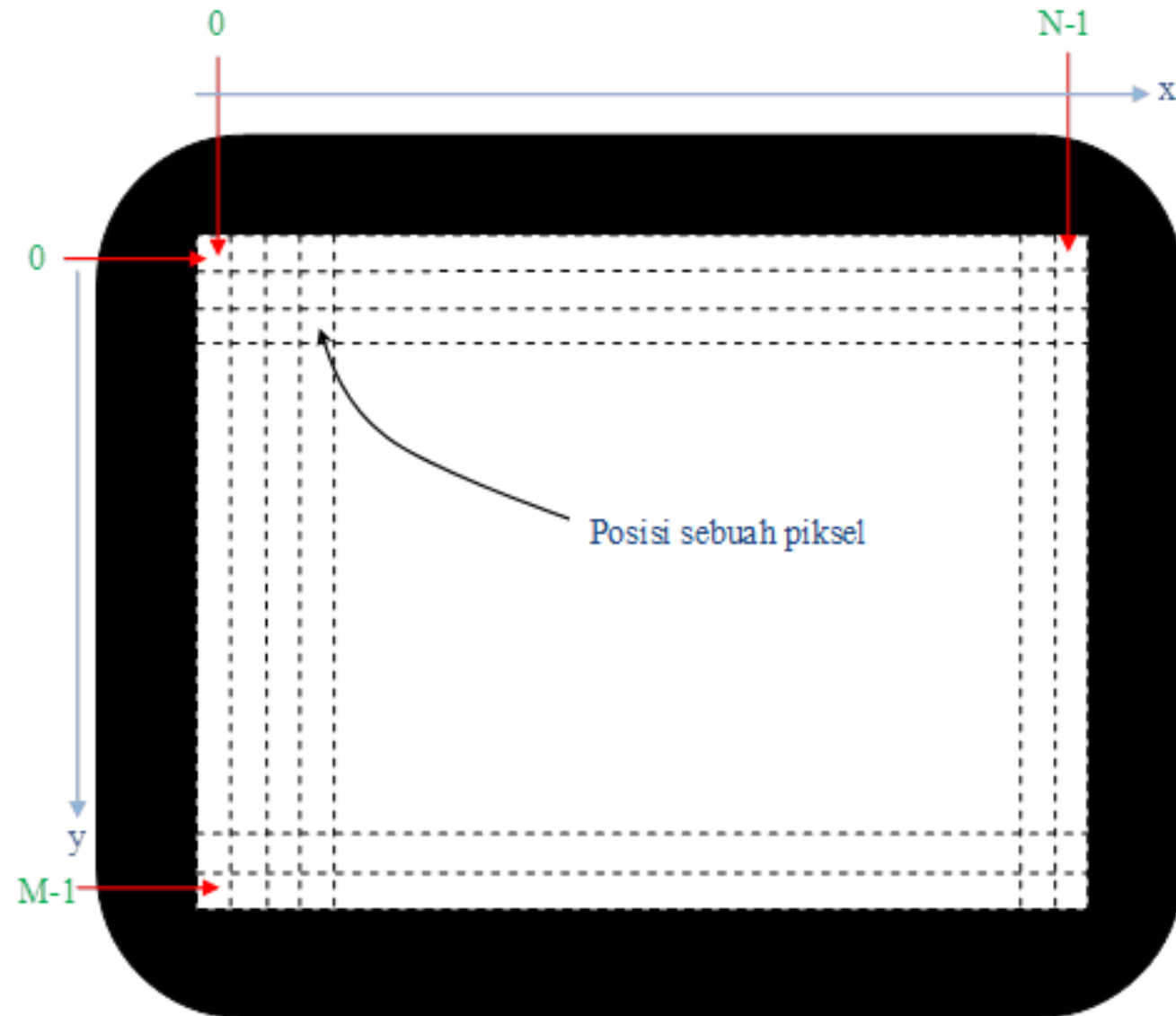
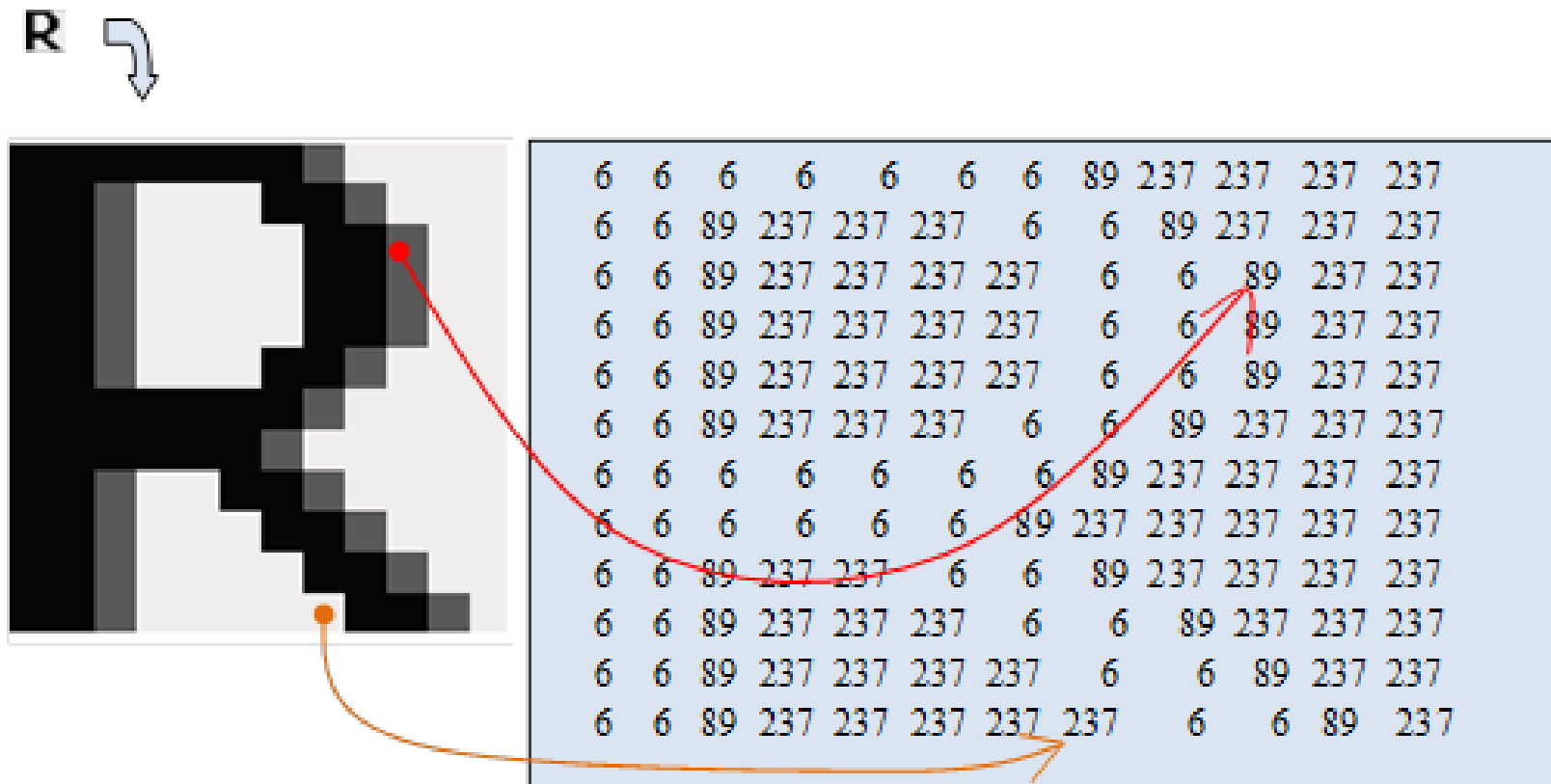


Image and pixel component



(a) Citra berukuran 12 x 12

(b) Data penyusun citra 12 x 12

Pixel notation in image

$f(2,1) = 6$

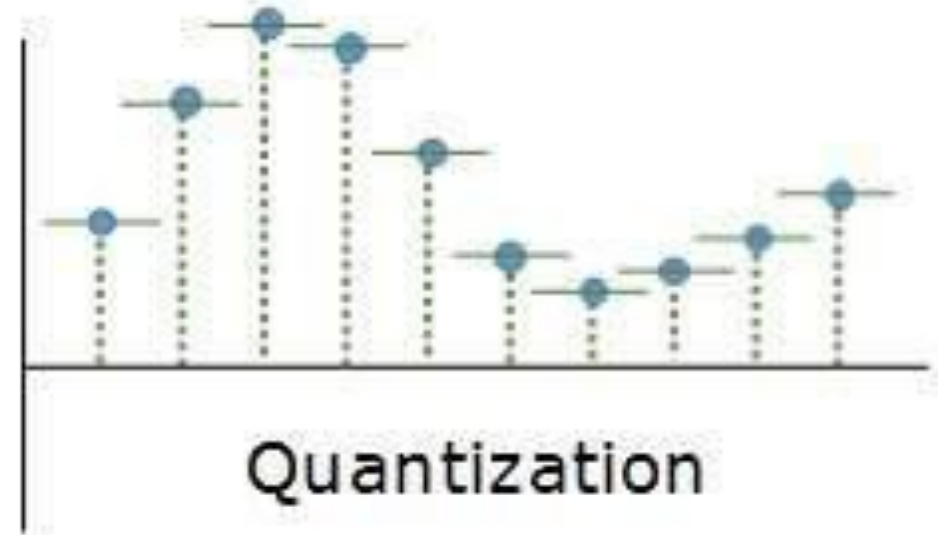
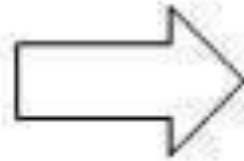
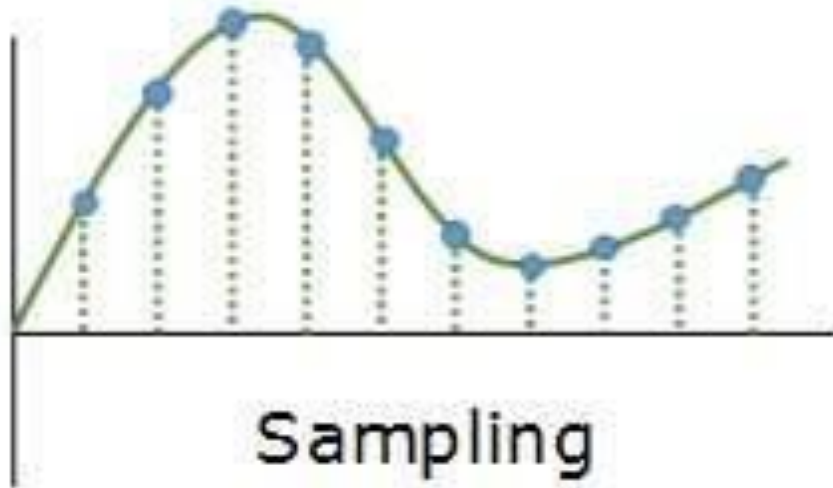
	1	2	3	4	5	6	7	8	9	10	11	12
1	6	6	6	6	6	6	6	89	237	237	237	237
2	6	6	89	237	237	237	6	6	89	237	237	237
3	6	6	89	237	237	237	237	6	6	89	237	237
4	6	6	89	237	237	237	237	6	6	89	237	237
5	6	6	89	237	237	237	237	6	6	89	237	237
6	6	6	89	237	237	237	6	6	89	237	237	237
7	6	6	6	6	6	6	6	89	237	237	237	237
8	6	6	6	6	6	6	89	237	237	237	237	237
9	6	6	89	237	237	6	6	89	237	237	237	237
10	6	6	89	237	237	237	6	6	89	237	237	237
11	6	6	89	237	237	237	237	6	6	89	237	237
12	6	6	89	237	237	237	237	237	6	6	89	237

$f(4,7) = 237$

quiz !

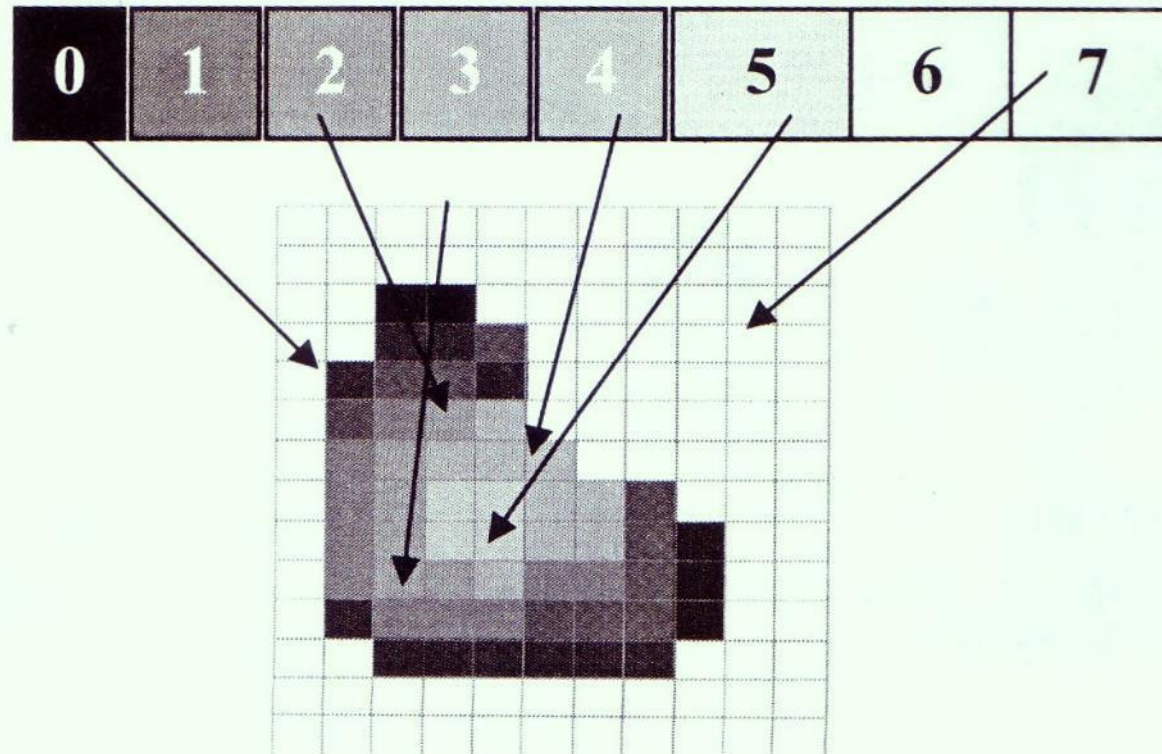
1	2	3	4	5
5	6	7	8	9
10	11	12	13	14
15	16	17	18	19
20	21	22	23	24

Tentukan notasi *dari*
tiap *pixel*!

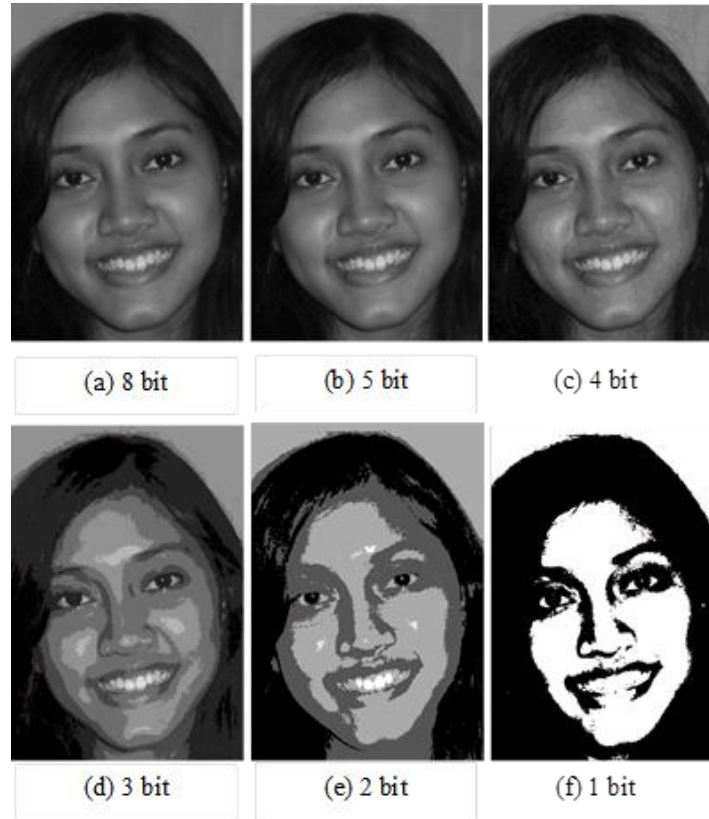


mengambil sebagian untuk merepresentasikan

quantization

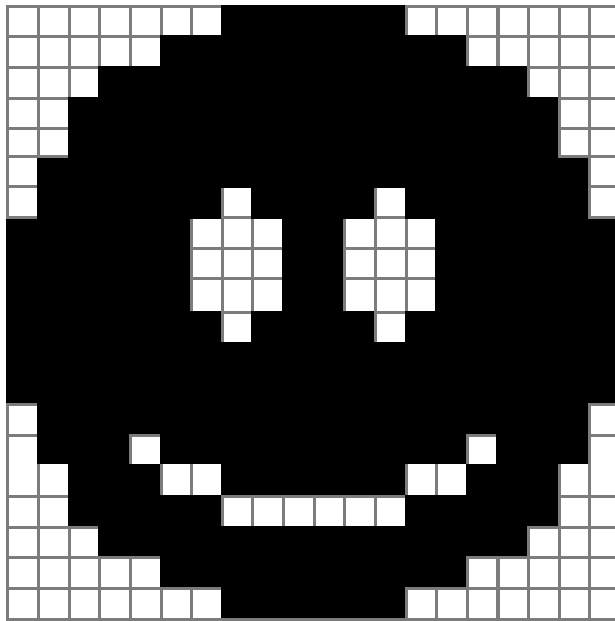


Quantization image samples

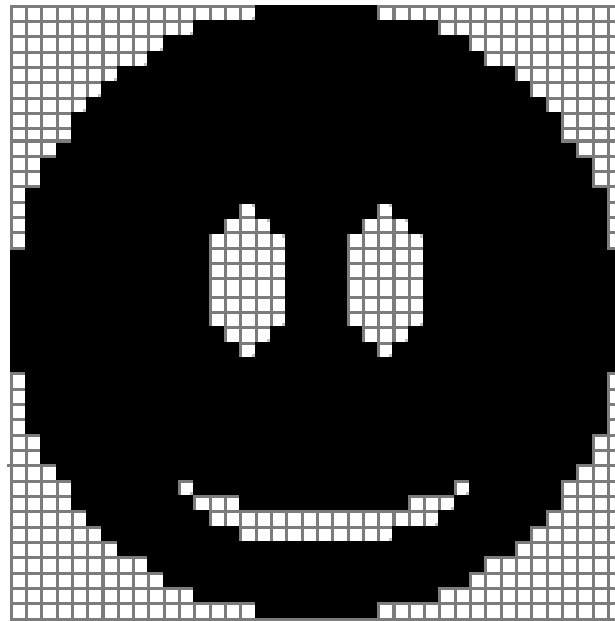


gambar cenderung sama

resolution



Canvas Size: 20 x 20 px
Resolution: 9 DPI



Canvas Size: 40 x 40 px
Resolution: 18 DPI



Canvas Size: 200 x 200 px
Resolution: 90 DPI

Question!

- *Scanner 500 DPI* dan *300 DPI* digunakan untuk mengakuisisi citra foto berwarna ukuran 3x4 inch,
 - Berapa ukuran *pixel* citra hasil *scan* dari tiap *scanner* ?
 - Jika tiap *pixel* terdiri dari 3 *byte* data (masing2 merepresentasikan *RGB*) dan *header* 1089 byte, berapa *file size* dari tiap citra?

Kinds of digital image

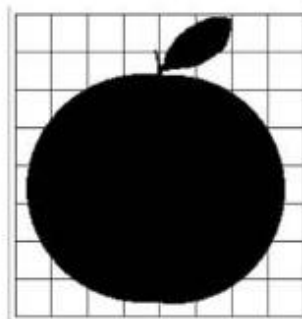
- Monochrome
- Grayscale
- True colour

Monochrome (binary image)

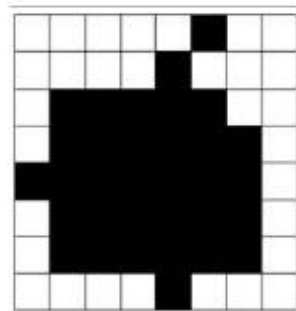
Digitalisasi citra biner 8x8 piksel



(a) Citra yang akan dinyatakan dalam isyarat digital



(b) Citra ditumpangkan pada grid



1	1	1	1	1	0	1	1
1	1	1	1	0	1	1	1
1	0	0	0	0	0	1	1
1	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1
1	0	0	0	0	0	0	1
1	0	0	0	0	0	0	1
1	1	1	1	0	1	1	1

Grayscale image

Citra 1 bit = $2^1 = 2$ gradasi warna



Citra 2 bit = $2^2 = 4$ gradasi warna



Citra 3 bit = $2^3 = 8$ gradasi warna



Citra 5 bit = $2^5 = 32$ gradasi warna



Citra 6 bit = $2^6 = 64$ gradasi warna



Citra 7 bit = $2^7 = 128$ gradasi warna



Citra 8 bit = $2^8 = 256$ gradasi warna



TrueColor image

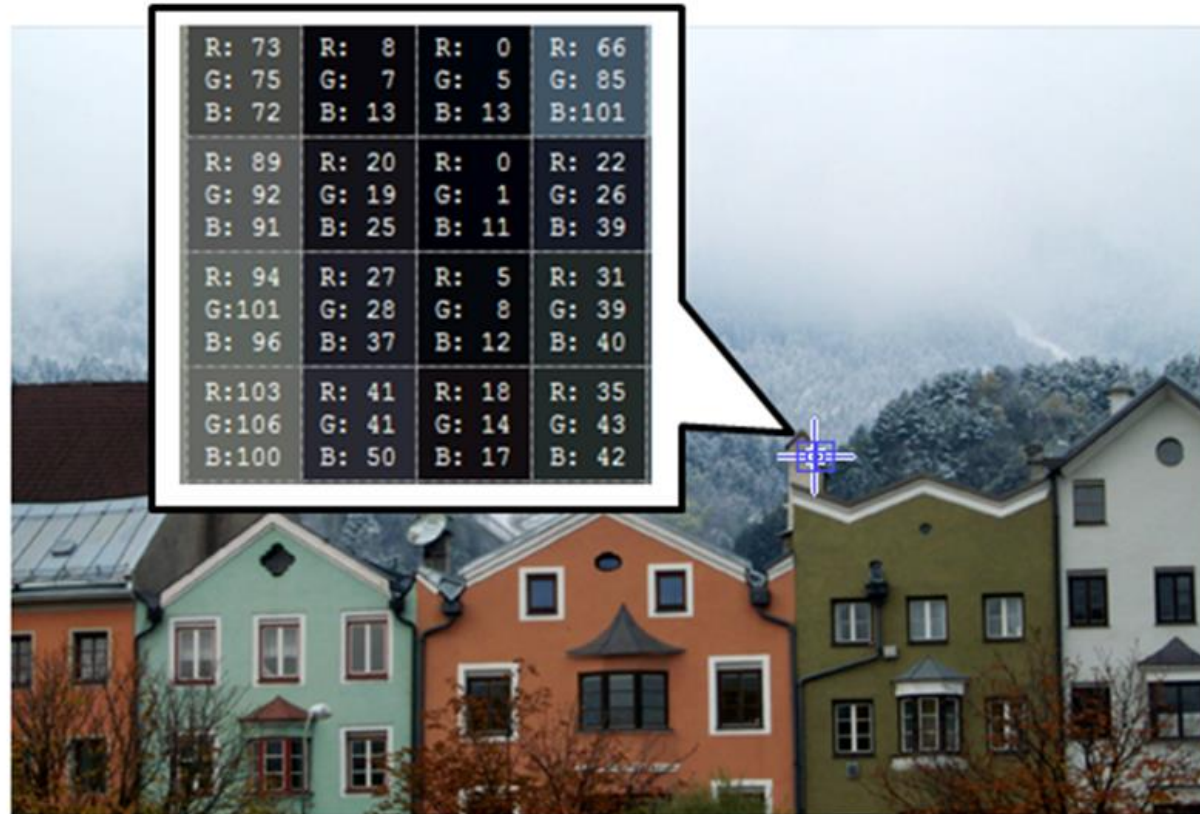


TABLE 2.1

Number of storage bits for various values of N and k . L is the number of intensity levels.

N/k	1 ($L = 2$)	2 ($L = 4$)	3 ($L = 8$)	4 ($L = 16$)	5 ($L = 32$)	6 ($L = 64$)	7 ($L = 128$)	8 ($L = 256$)
32	1,024	2,048	3,072	4,096	5,120	6,144	7,168	8,192
64	4,096	8,192	12,288	16,384	20,480	24,576	28,672	32,768
128	16,384	32,768	49,152	65,536	81,920	98,304	114,688	131,072
256	65,536	131,072	196,608	262,144	327,680	393,216	458,752	524,288
512	262,144	524,288	786,432	1,048,576	1,310,720	1,572,864	1,835,008	2,097,152
1024	1,048,576	2,097,152	3,145,728	4,194,304	5,242,880	6,291,456	7,340,032	8,388,608
2048	4,194,304	8,388,608	12,582,912	16,777,216	20,971,520	25,165,824	29,369,128	33,554,432
4096	16,777,216	33,554,432	50,331,648	67,108,864	83,886,080	100,663,296	117,440,512	134,217,728
8192	67,108,864	134,217,728	201,326,592	268,435,456	335,544,320	402,653,184	469,762,048	536,870,912

- N = ukuran citra
- K = bit depth citra
- Dengan ukuran citra $n=32$ (Asumsi citra tinggi dan lebar sama) dan kedalaman $k=8$, maka ukuran citra adalah:
- $b = 32 \times 32 \times 8 = 8192$ bit

Ukuran Citra

- Citra Grayscale 8-bit berukuran $640 \times 480 = 640 \times 480 \times 8 = 2.457.600\text{bit} = 307.200 \text{ byte} = 300\text{KB}$
- Citra Warna 24-bit berukuran $640 \times 480 = 640 \times 480 \times 24 = 7.372.800\text{bit} = 921.600 \text{ byte} = 900\text{KB}$ (**921KB??**)

File Format

- Raster (JPEG, Exif, TIFF, GIF, BMP, PNG)
- Vector (CGM, SVG, VML, CDR, BLEND, VRML)

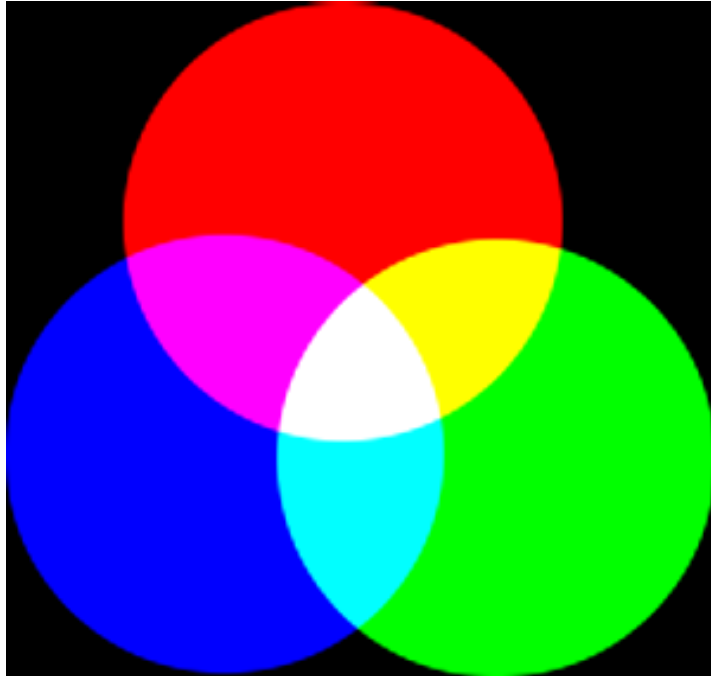
Bitmap image formats

FORMAT	FILE EXTENSION	TYPE OF COMPRESSION	METHODS	USAGE
BMP (bitmap)	.bmp	Considerably compressed with lossless	ZIP	used to store bitmap digital images
JPEG (Joint Photographic Experts Group)	.jpg , .jpeg , .jpe	Lossy Lossless	- Discrete Cosine Transform (DCT) & Chroma Subsampling - Run-Length Encoding (RLE)	For natural images
GIF (Graphics Interchange Format)	.gif , .giff , .gfa	Lossless	LZW (Lempel-Ziv-Welch)	For artificial images (sharp-edge lines and few colors) & support animation
PNG (Portable Network Graphics)	.png	Lossless	DEFLATE	Better compression & features than GIF, but don't support animation
TIFF (Tagged Image File Format)	.tiff , .tif	Lossless	RLE / LZW / DEFLATE / ZIP	Flexible file format, can store multiple images in a single file
JPEG2000	jp2, .j2c, jpc, j2k, jpx	Lossy & Lossless	Discrete Wavelet Transform (DWT)	Better image quality than JPEG (up to 20%), not widely used because of some patent issues.

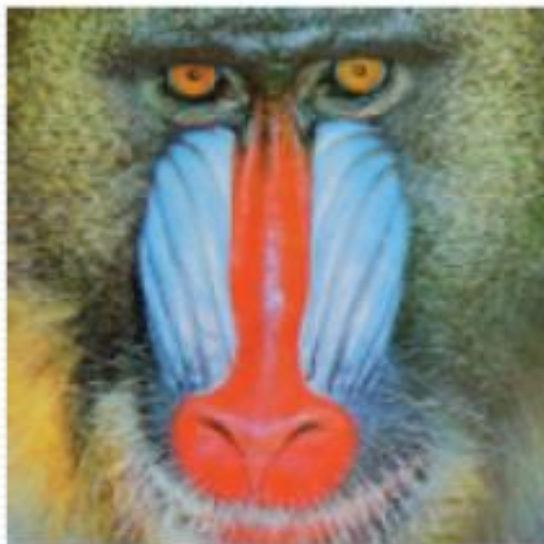
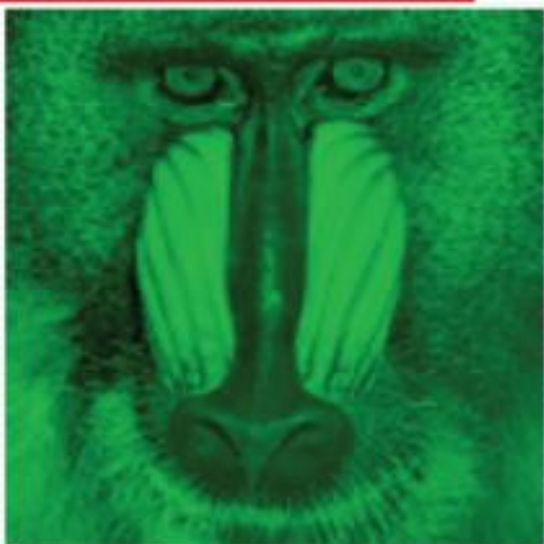
Vector image formats

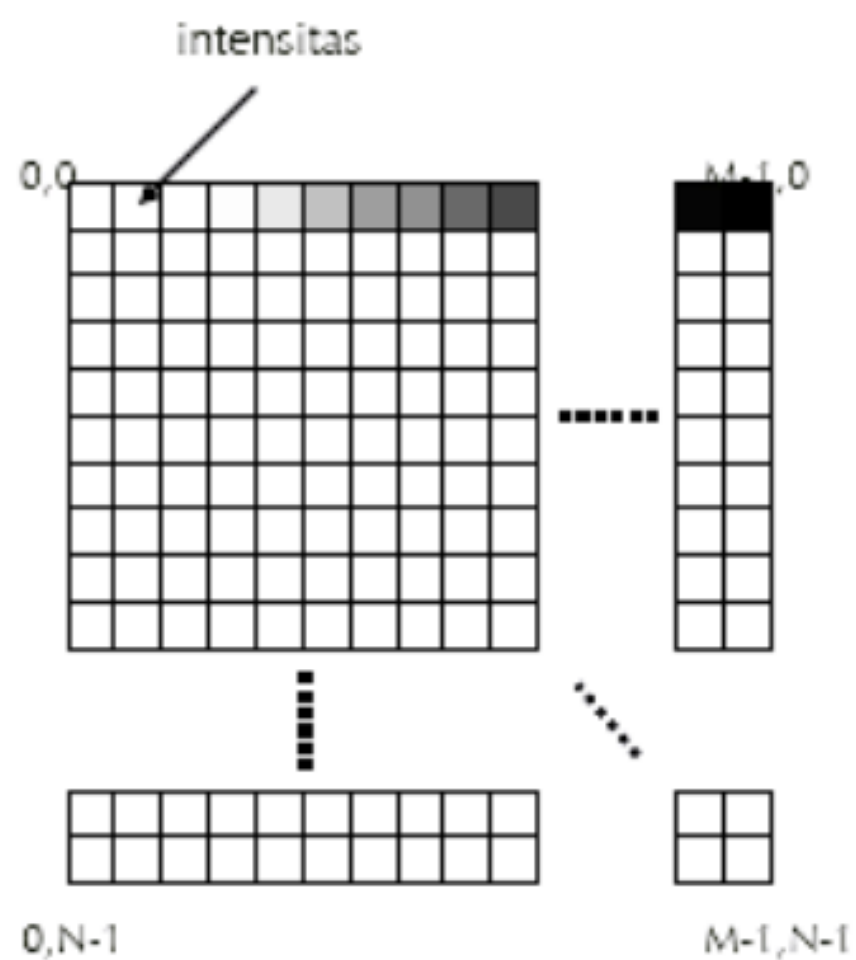
COMMON VECTOR FORMATS	
AI	Adobe Illustrator file
CDR	CORELDraw file
CGM	Computer Graphics Metafile
DXF or DWG	AutoCAD file
EMF	Enhance Metafile
EPS	Encapsulated PostScript file
FH	Macromedia FreeHand file
PIC or PCT	Macintosh PICT
SWF	ShockWave Flash
SVG	Scaleable Vector Graphis
WMF	Windows Metafiles

RGB

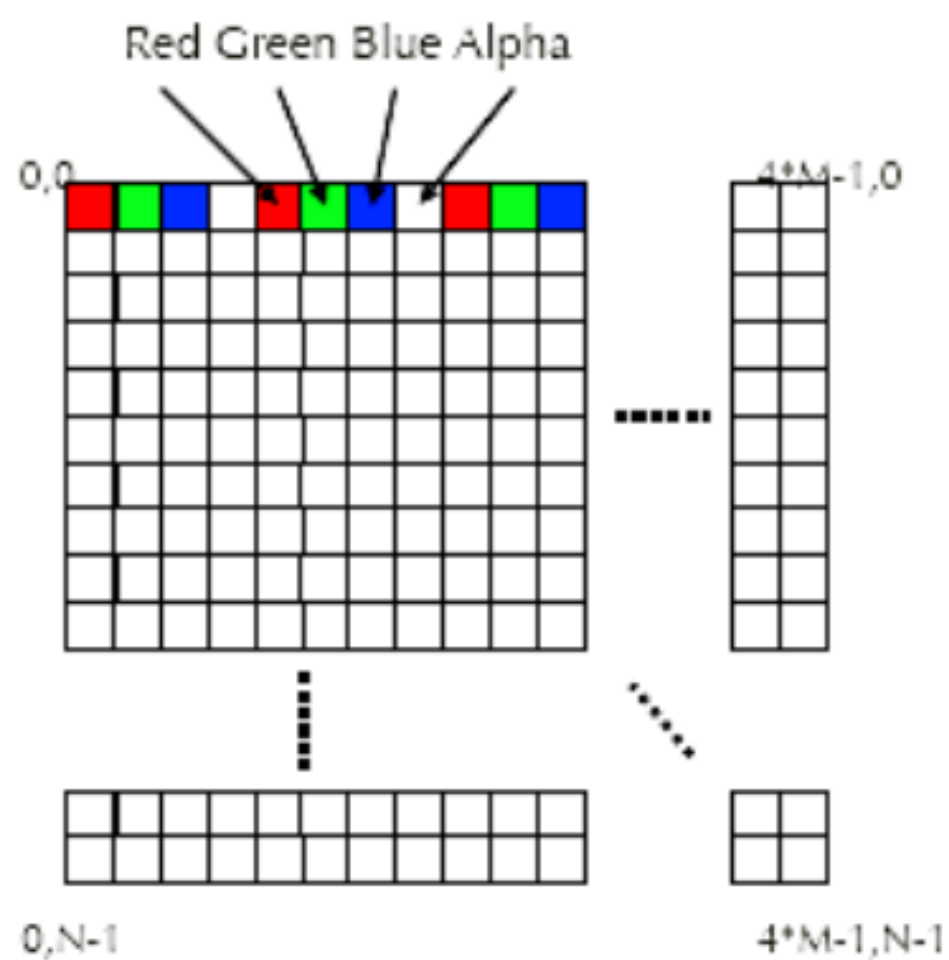


- RGB Color Mode bersifat additive
- Jika menggunakan 8 bit perchannel, maka memiliki 16,777,216 warna ($256 \times 256 \times 256$)
- Menggabungkan dua warna utama RGB menghasilkan warna sekunder, yang disebut dengan model CMY.
- Biru-Hijau = Cyan, Biru-Merah = Magenta, Merah-Hijau = Kuning (Yellow)

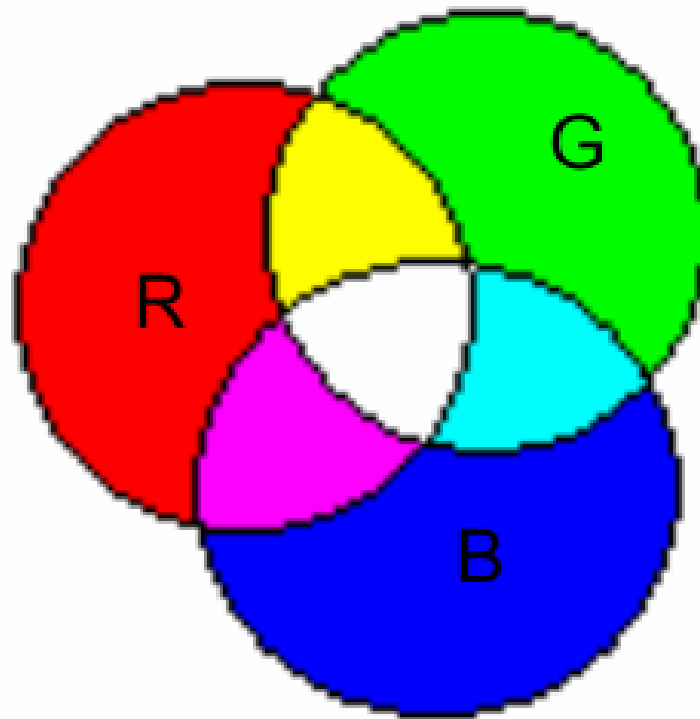




Binary or
Gray



Color



Format warna 24 BIT dinyatakan dengan:

11001001










R (8 bit)

01011001

G (8 bit)

00001011

B (8 bit)

Warna		R	G	B
Merah		255	0	0
Hijau		0	255	0
Biru		0	0	255
Kuning		255	255	0
Magenta		255	0	255
Cyan		0	255	255
Putih		255	255	255
Hitam		0	0	0
Abu-abu		128	128	128

Nilai	Warna		Nilai	Warna
0x00000000	Hitam		0x0000AAFF	Orange
0x000000FF	Merah		0x00888888	Abu-abu
0x0000FF00	Hijau		0x00FF00AA	Ungu
0x00FF0000	Biru		0x00AAFF00	Hijau Muda
0x0000FFFF	Kuning		0x00AA00FF	Merah Muda
0x00FF00FF	Magenta		0x00AAFFFF	Kuning Muda
0x00FFFFFF00	Cyan		0x000088AA	Coklat
0x00FFFFFFF	Putih		0x00AA0088	Ungu

Image Elements

- Brightness
- Contrast
- Contour
- Color
- Shape
- Texture

Kecerahan (*brightness*)

Kecerahan adalah kata lain untuk intensitas cahaya.

Kecerahan pada titik (*pixel*) di dalam citra bukanlah intensitas yang riil. Tetapi sebenarnya adalah intensitas rata-rata dari suatu area yang melingkupinya.

Sistem *visual* manusia mampu menyesuaikan dirinya dengan tingkat kecerahan mulai dari yang paling rendah sampai yang paling tinggi



Kontras (*contrast*)

Kontras menyatakan sebaran terang (*lightness*) dan gelap (*darkness*) di dalam gambar.

Citra dengan kontras rendah dicirikan oleh komposisi citranya adalah sebagian besar terang atau gelap. Pada citra dengan kontras yang baik, komposisi gelap dan terang tersebar secara merata.



Kontur (contour)

Kontur adalah keadaan yang ditimbulkan oleh perubahan intensitas pada *pixel-pixel* yang bertetangga.

Karena adanya perubahan intensitas inilah, maka tepi-tepi (*edge*) objek pada citra dapat dideteksi.

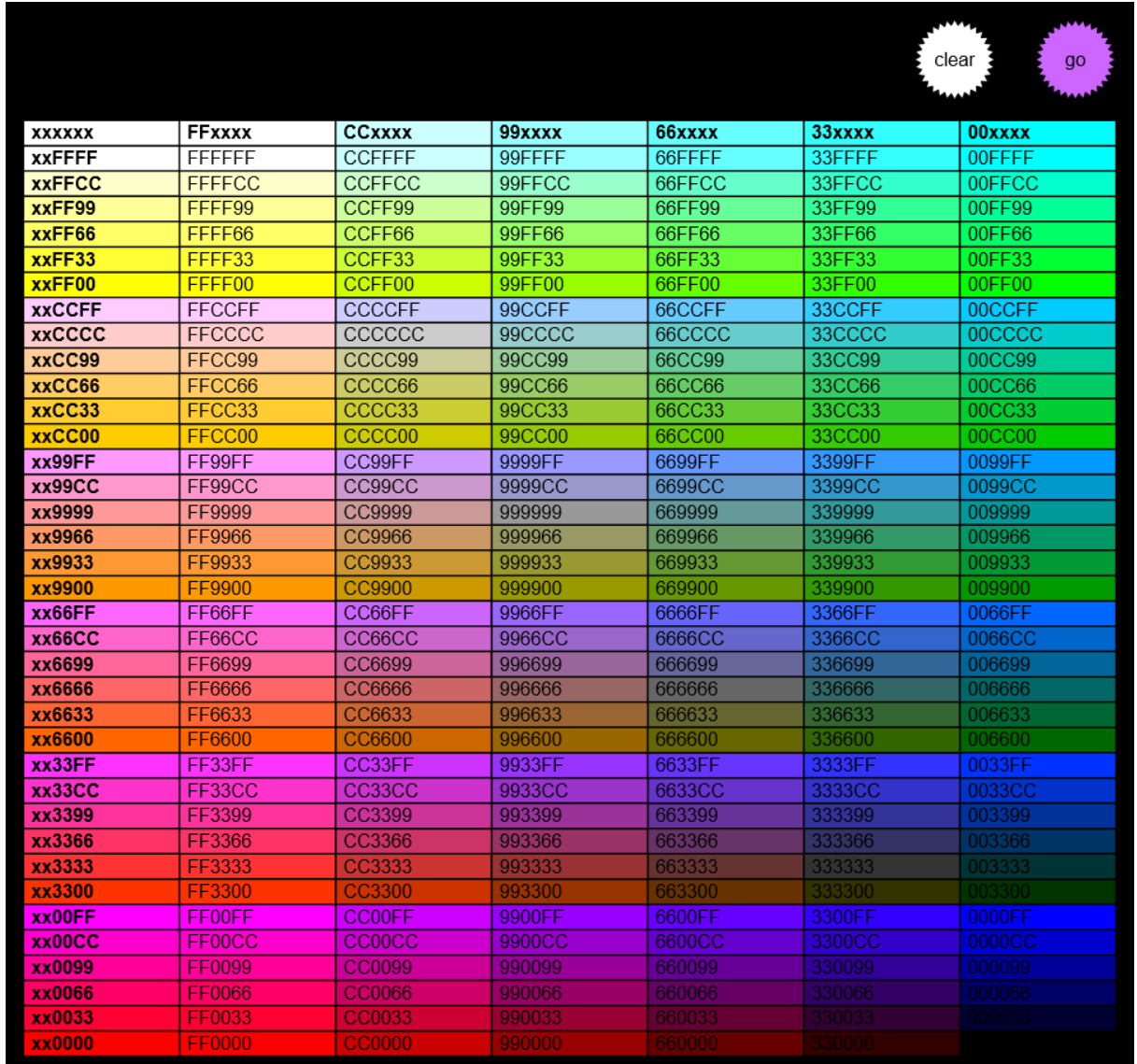


Warna (color)

Warna adalah persepsi yang dirasakan oleh sistem visual manusia terhadap panjang gelombang cahaya yang dipantulkan oleh objek.

Setiap warna mempunyai panjang gelombang yang berbeda-beda.

Warna yang diterima oleh sistem visual manusia (mata) merupakan hasil kombinasi cahaya dengan panjang gelombang yang berbeda-beda. Kombinasi warna yang memberikan rentang warna yang paling lebar adalah *red (R)*, *green(G)*, dan *blue(B)*.

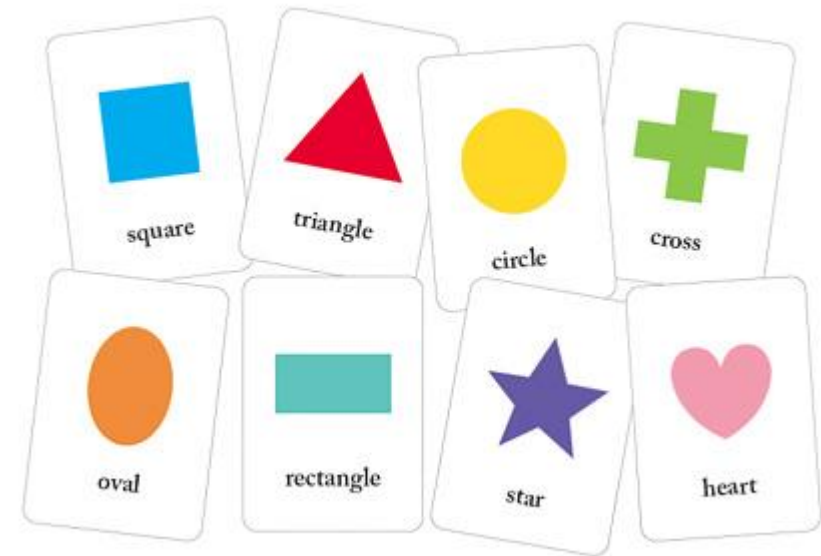


xxxxxx	FFxxxx	CCxxxx	99xxxx	66xxxx	33xxxx	00xxxx
xxFFFF	FFFFFF	CCFFFF	99FFFF	66FFFF	33FFFF	00FFFF
xxFFCC	FFFFCC	CCFFCC	99FFCC	66FFCC	33FFCC	00FFCC
xxFF99	FFFF99	CCFF99	99FF99	66FF99	33FF99	00FF99
xxFF66	FFFF66	CCFF66	99FF66	66FF66	33FF66	00FF66
xxFF33	FFFF33	CCFF33	99FF33	66FF33	33FF33	00FF33
xxFF00	FFFF00	CCFF00	99FF00	66FF00	33FF00	00FF00
xxCCFF	FFCCFF	CCCCFF	99CCFF	66CCFF	33CCFF	00CCFF
xxCCCC	FFCCCC	CCCCCC	99CCCC	66CCCC	33CCCC	00CCCC
xxCC99	FFCC99	CCCC99	99CC99	66CC99	33CC99	00CC99
xxCC66	FFCC66	CCCC66	99CC66	66CC66	33CC66	00CC66
xxCC33	FFCC33	CCCC33	99CC33	66CC33	33CC33	00CC33
xxCC00	FFCC00	CCCC00	99CC00	66CC00	33CC00	00CC00
xx99FF	FF99FF	CC99FF	9999FF	6699FF	3399FF	0099FF
xx99CC	FF99CC	CC99CC	9999CC	6699CC	3399CC	0099CC
xx9999	FF9999	CC9999	999999	669999	339999	009999
xx9966	FF9966	CC9966	999966	669966	339966	009966
xx9933	FF9933	CC9933	999933	669933	339933	009933
xx9900	FF9900	CC9900	999900	669900	339900	009900
xx66FF	FF66FF	CC66FF	9966FF	6666FF	3366FF	0066FF
xx66CC	FF66CC	CC66CC	9966CC	6666CC	3366CC	0066CC
xx6699	FF6699	CC6699	996699	666699	336699	006699
xx6666	FF6666	CC6666	996666	666666	336666	006666
xx6633	FF6633	CC6633	996633	666633	336633	006633
xx6600	FF6600	CC6600	996600	666600	336600	006600
xx33FF	FF33FF	CC33FF	9933FF	6633FF	3333FF	0033FF
xx33CC	FF33CC	CC33CC	9933CC	6633CC	3333CC	0033CC
xx3399	FF3399	CC3399	993399	663399	333399	003399
xx3366	FF3366	CC3366	993366	663366	333366	003366
xx3333	FF3333	CC3333	993333	663333	333333	003333
xx3300	FF3300	CC3300	993300	663300	333300	003300
xx00FF	FF00FF	CC00FF	9900FF	6600FF	3300FF	0000FF
xx00CC	FF00CC	CC00CC	9900CC	6600CC	3300CC	0000CC
xx0099	FF0099	CC0099	990099	660099	330099	000099
xx0066	FF0066	CC0066	990066	660066	330066	000066
xx0033	FF0033	CC0033	990033	660033	330033	000033
xx0000	FF0000	CC0000	990000	660000	330000	000000

Bentuk (shape)

Bentuk adalah properti intrinsik dari objek tiga dimensi.

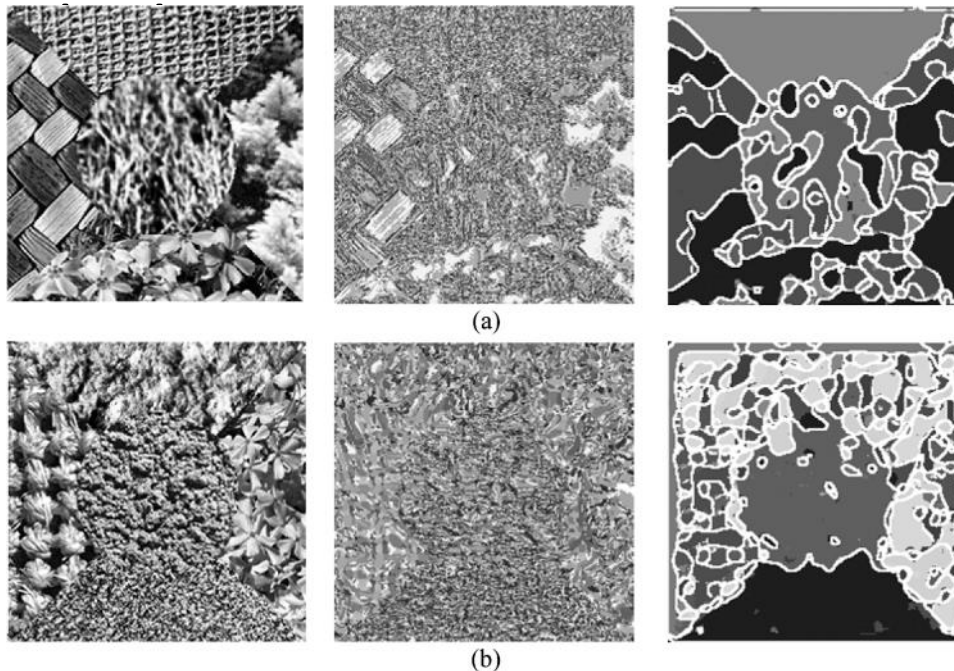
Bentuk merupakan properti intrinsik utama untuk sistem visual manusia karena manusia lebih sering menginterpretasikan suatu objek berdasarkan bentuknya daripada elemen lainnya.



Tekstur (texture)

Tekstur dicirikan sebagai distribusi spasial dari derajat keabuan di dalam sekumpulan *pixel-pixel* yang bertetangga. Sehingga, tekstur tidak dapat didefinisikan untuk sebuah *pixel*.

Tekstur merupakan karakteristik untuk menganalisa permukaan berbagai jenis citra



- Gray-scale images

$$I(x,y) \in [0..255]$$



- Binary images

$$I(x,y) \in \{0, 1\}$$



- Color images

$$I_R(x,y) \quad I_G(x,y) \quad I_B(x,y)$$

