



4

- 가?
- 가
- Redundancy Visibility
-
-



가?



❖ 1024 x 1024 RGB

• $1024 \times 1024 \times 3 \times 8\text{bit} = 3 \text{ Mbytes}$



❖ 30 frames/sec :

• $3 \text{ Mbytes} \times 30 \text{ frames/sec} = 90 \text{ Mbytes/sec}$

❖ 64 Kbps ISDN

:

• $90 \text{ Mbytes} / 8\text{Kbytes} = 3 \text{ hours}$

❖ = 11,250 : 1



.



가

■ 가

1)

2)

3)

■



:

- : 512 x 480, 24 bits-per-pixel (bpp)
- (bitstream) : 15,000 bytes
- = $(512 \times 480 \times 3) / 15,000 = 49 : 1$



,

가 256 x 240

:

- = $49 / 4 = 12 : 1$



: bpp (bits-per-pixel)

- $(15,000 \times 8) / (256 \times 240) = 2 \text{ bpp}$



가



(Lossless compression)



(Lossy compression)



:

가

.



:

.



-

가



가

:

H/W(JPEG Chip),

H/W(DSP Chip)



Redundancy

Visibility

■ Redundancy

- ❖
- ❖ Redundancy :
 - (spatial) redundancy
 - redundancy
 - (temporal) redundancy
 - redundancy

■ Visibility

- ❖
- ❖ , ()
 - : color subsampling



()



- ❖ (Simple compression techniques)
- ❖ (Interpolative techniques)
- ❖ (Predictive techniques)
- ❖ (Transform coding techniques)
- ❖ (Statistical coding)



()

■ Truncation



-) R:G:B = 8:8:8 (24bpp) R:G:B = 5:5:5 + 1 (flag bit)
(16bpp)

■ CLUT (Color Lookup Table)



()

-) 24bpp ($2^{24} = 16$ million colors) 8bpp ($2^8 = 256$ colors)

■ RLE (Run Length Encoding)

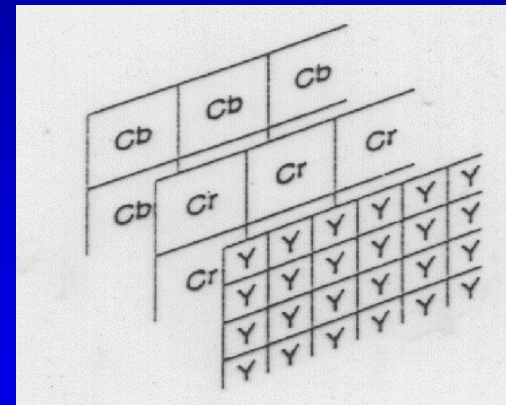
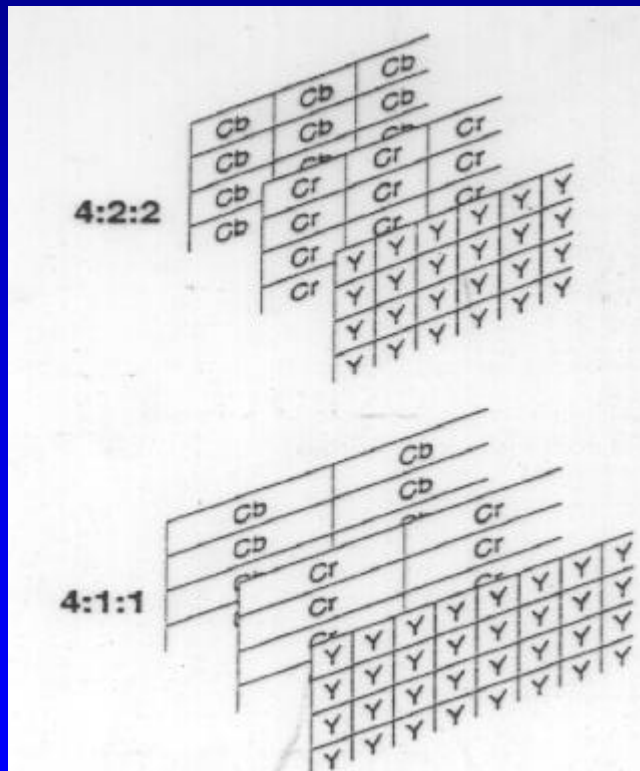


- : 1 1 1 1 1 1 1 4 4 4 4 4 3 3 3 3
- RLE : (7,1) (5,4) (4,3)



()

■ Color subsampling



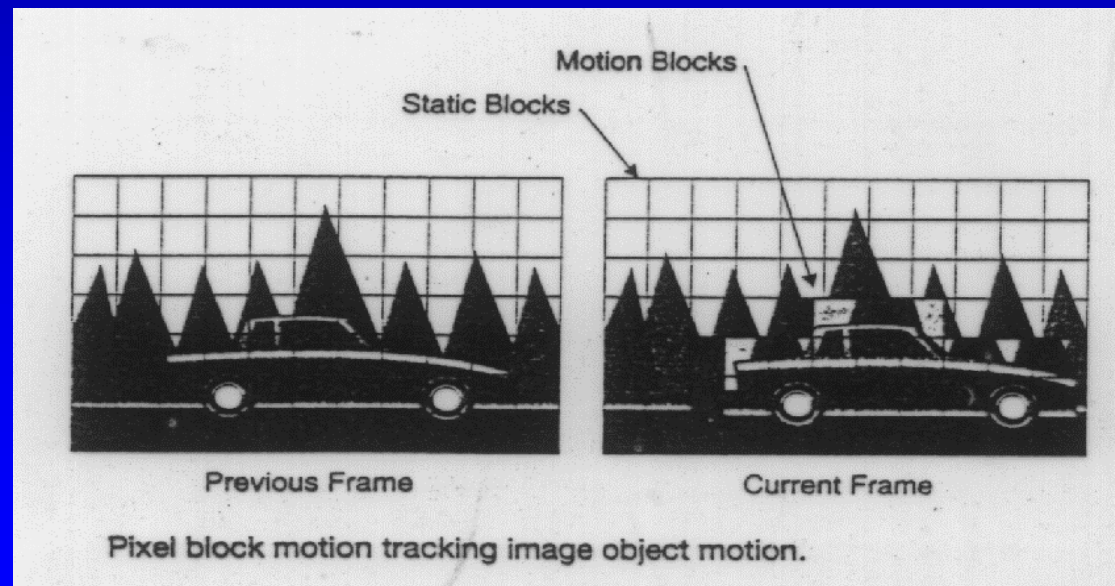
Bidirectional color subsampling



()

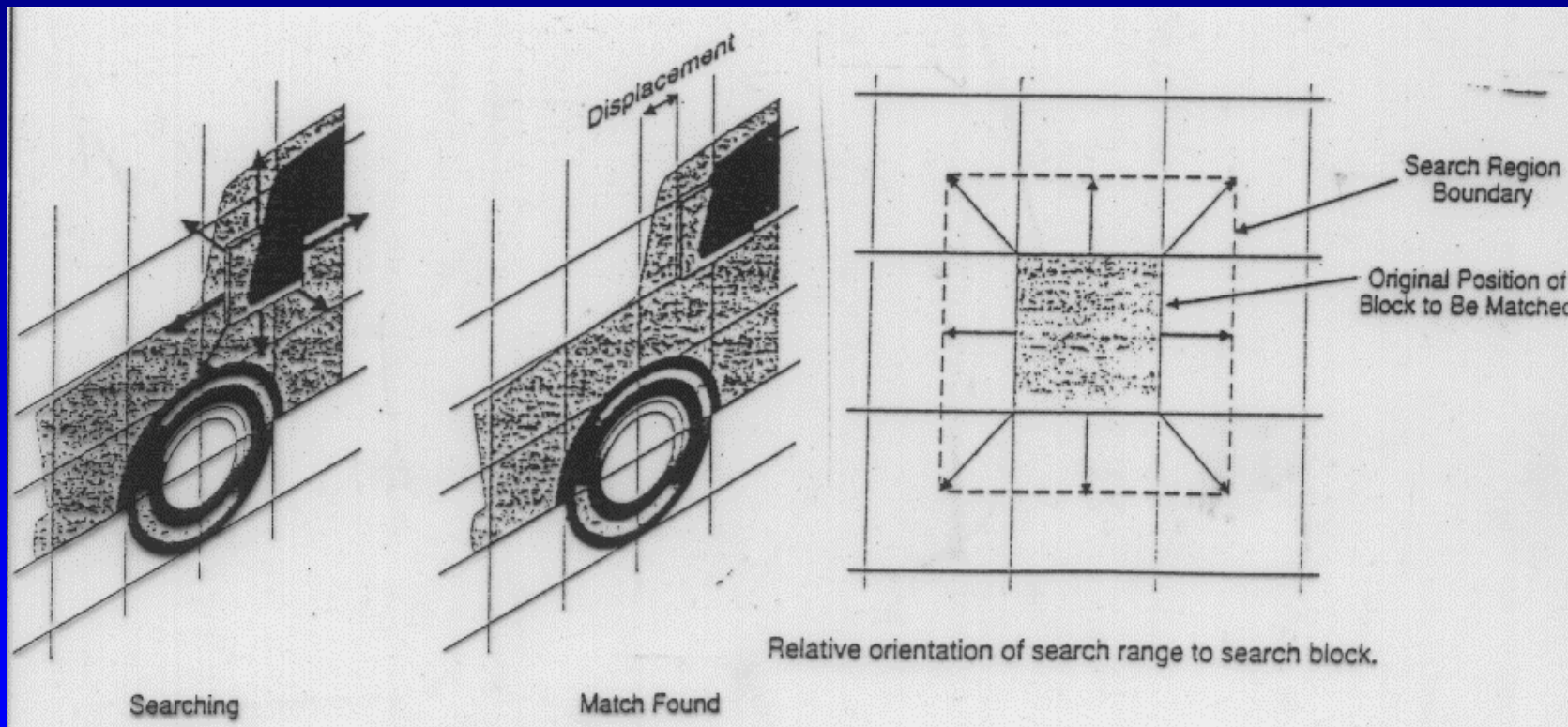
■ Frame Interpolation

- ❖ (Motion estimation)
-
- ❖ (Motion compensation)
-





()





()

■ Pixel Level

- ❖ DPCM (Differential PCM)
- ❖ ADPCM (Adaptive DPCM)

■ Frame Level

- ❖ Predicted frames
- ❖ :
 - MPEG P-picture B-picture



()

■ DCT (Discrete Cosine Transform) : 2D, 8 x 8

❖ FDCT (Forward DCT)

$$F(u,v) = \left(\frac{1}{4}\right) C(u)C(v) \sum_{i=0}^7 \sum_{j=0}^7 f(i,j) \cos\left(\frac{(2i+1)u\mathbf{p}}{16}\right) \cos\left(\frac{(2j+1)v\mathbf{p}}{16}\right)$$

$$C(x) = \begin{cases} 1/\sqrt{2}, & x=0 \\ 1, & \textit{otherwise} \end{cases}$$

❖ IDCT (Inverse DCT)

$$f(i,j) = \left(\frac{1}{4}\right) \sum_{u=0}^7 \sum_{v=0}^7 C(u)C(v) F(u,v) \cos\left(\frac{(2i+1)u\mathbf{p}}{16}\right) \cos\left(\frac{(2j+1)v\mathbf{p}}{16}\right)$$



()

■ Huffman coding (entropy coding)

❖ ,

❖ (lossless coding)

❖ :

Gray-level	Probability
0	0.1
1	0.3
2	0.4
3	0.1
4	0.06
5	0.04



()

<u>Codes</u>	<u>Gray-level</u>	<u>Prob.</u>	<u>Step1</u>	<u>Step2</u>	<u>Step3</u>	<u>Step4</u>
1	2	0.4	0.4	0.4	0.4	0.6 (0)
00	1	0.3	0.3	0.3	0.3	0.4 (1)
011	0	0.1	0.1	0.2 (010)	0.3 (01)	
0100	3	0.1	0.1	0.1 (011)		
01010	4	0.06 (01010)	0.1 (0101)			
01011	5	0.04 (01011)				



■ ISO/IEC (JTC1)

- ❖ JPEG (Joint Photographic Experts Group) - Color/gray scale still image
- ❖ JBIG (Joint Bi-level Image Experts Group)
- ❖ MPEG (Moving Picture Experts Group)
 - MPEG1 : bit rates = up to 1.5 Mbps
 - MPEG2 : bit rates = about 2 - 15 Mbps (supporting HDTV)
 - MPEG4 : for very low-bit rate (about 64 Kbps) audio-visual services
- ❖ MHEG - Multimedia / Hypermedia

■ CCITT SG XV

- ❖ Moving image : videophone, video conference (H.261)

■ CCIR/CCITT

- ❖ HDTV