

大话成像之 数字成像系统 32讲

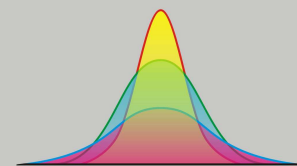
Encoder

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staff camera engineer

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编码的发展历史

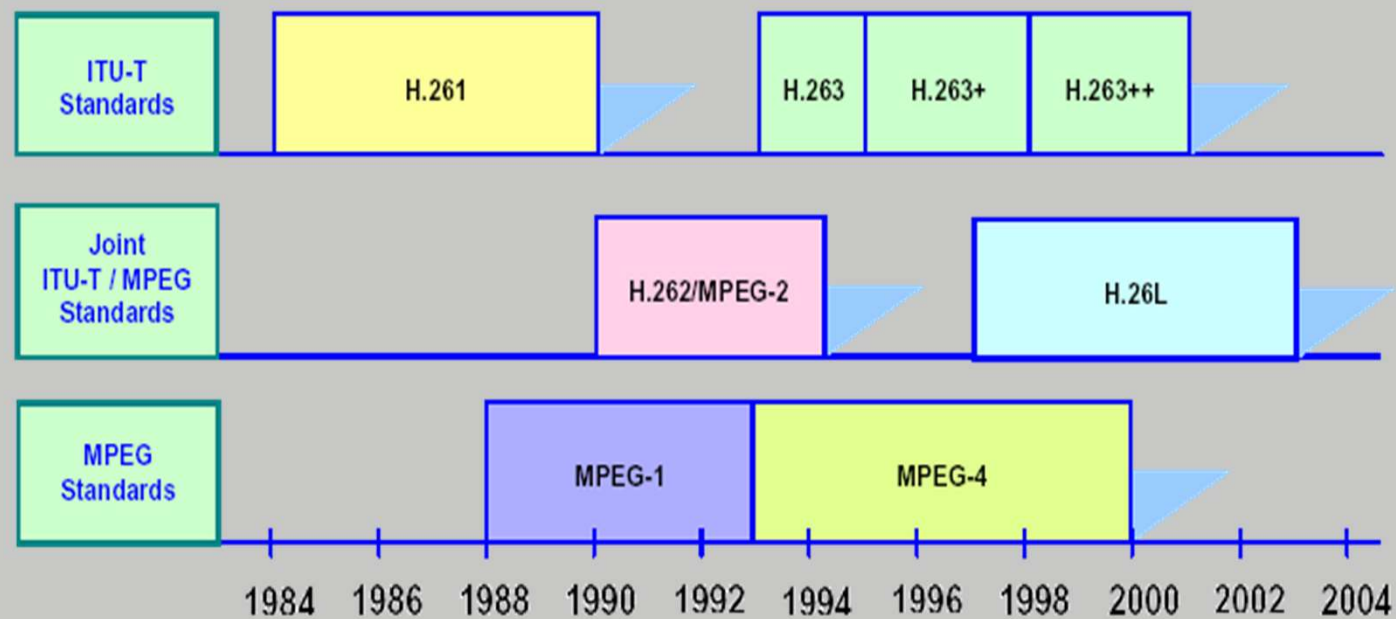
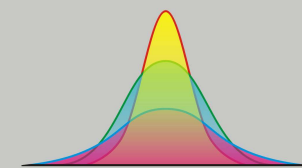
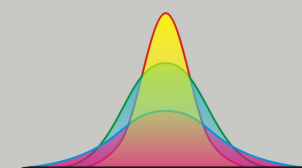
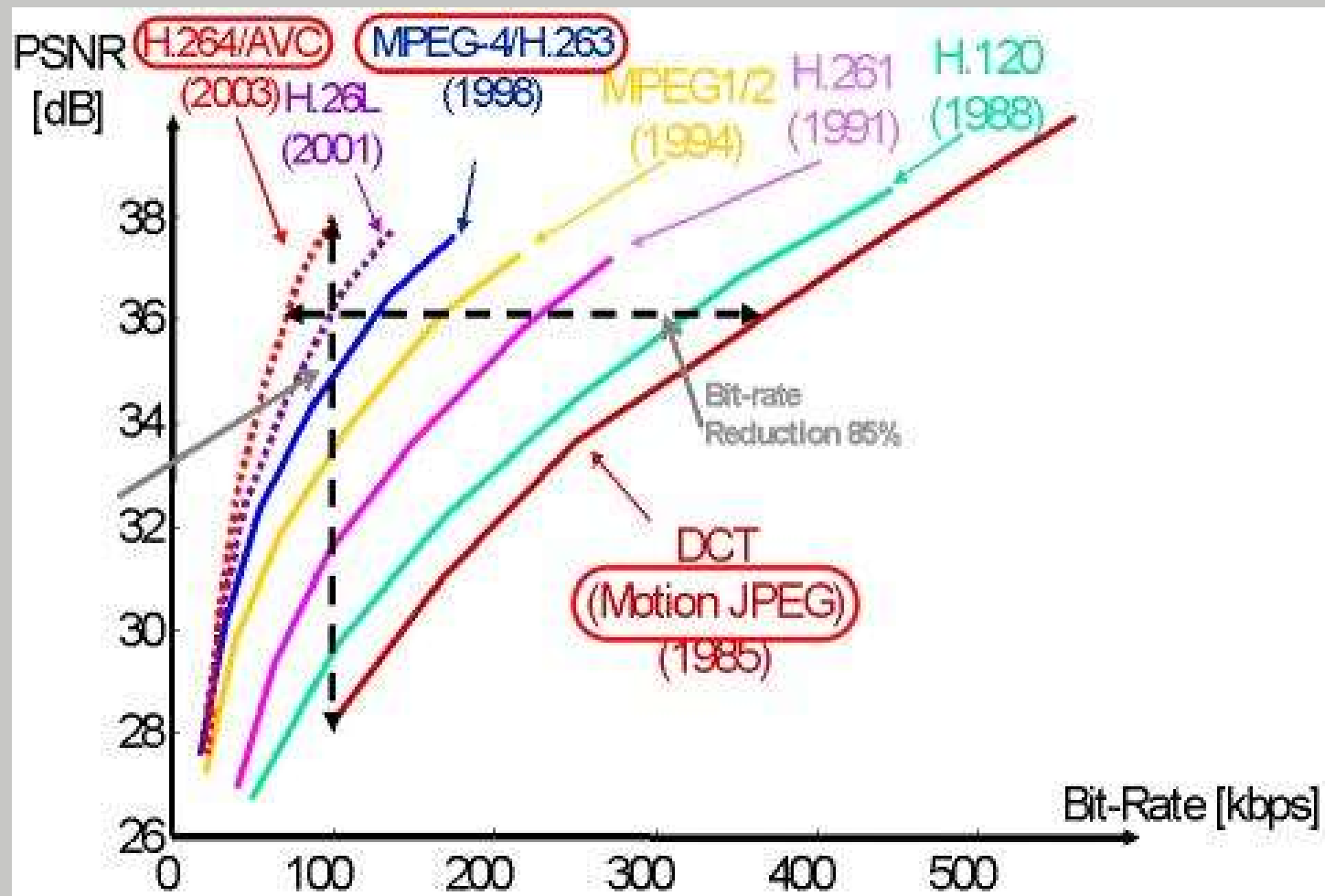


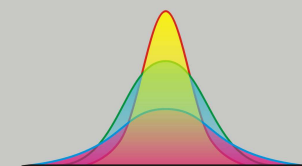
Figure 1. Progression of the ITU-T Recommendations and MPEG standards.



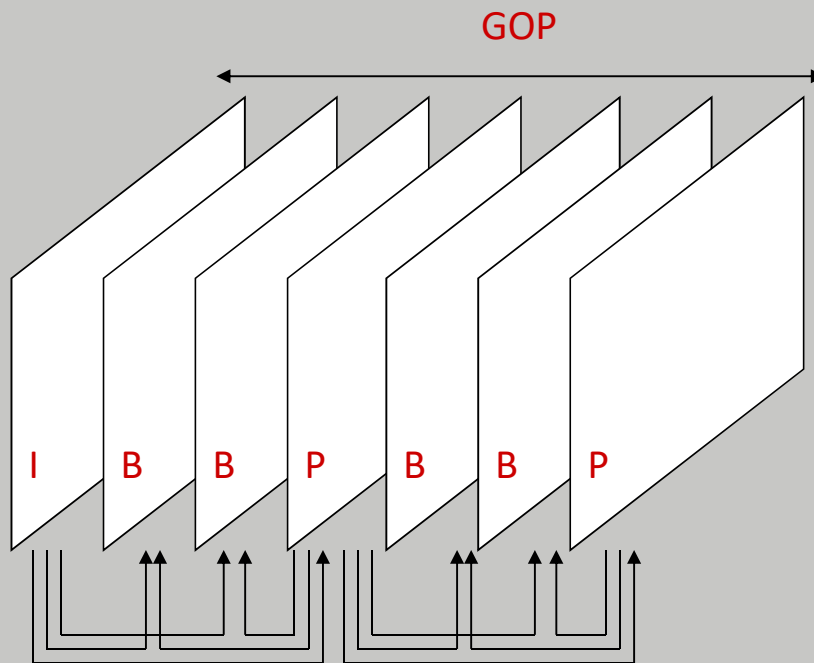


压缩编码的基本概念

- 有损压缩和无损压缩
- 帧内压缩和帧间压缩
- 对称编码和不对称编码



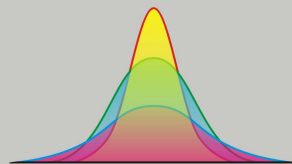
GOP



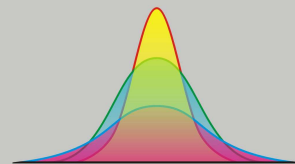
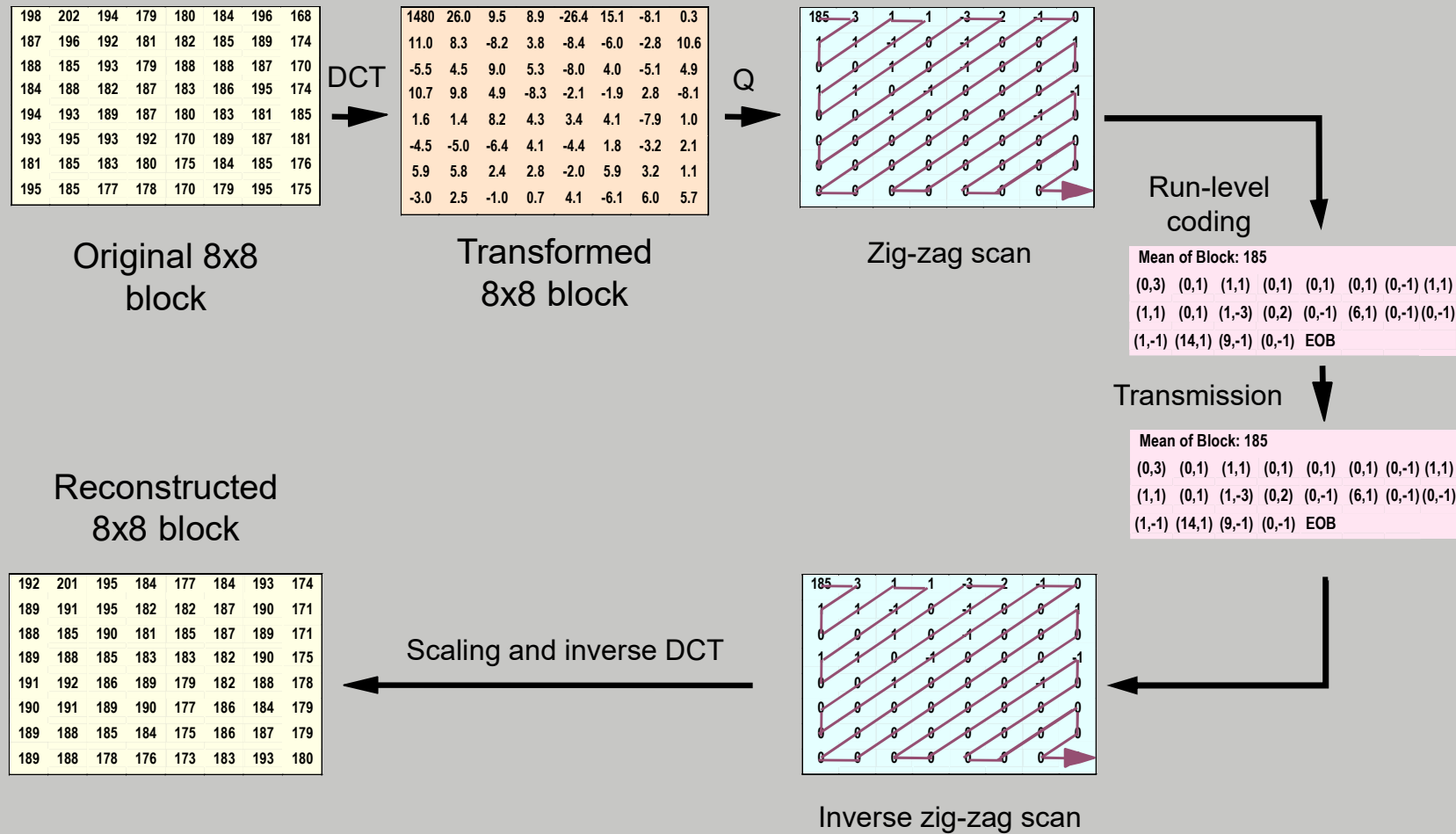
Encode/Decode Sequence: I P B B P B B

Display Sequence: I B B P B B P

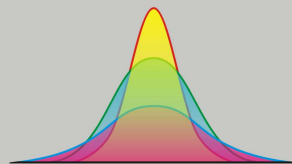
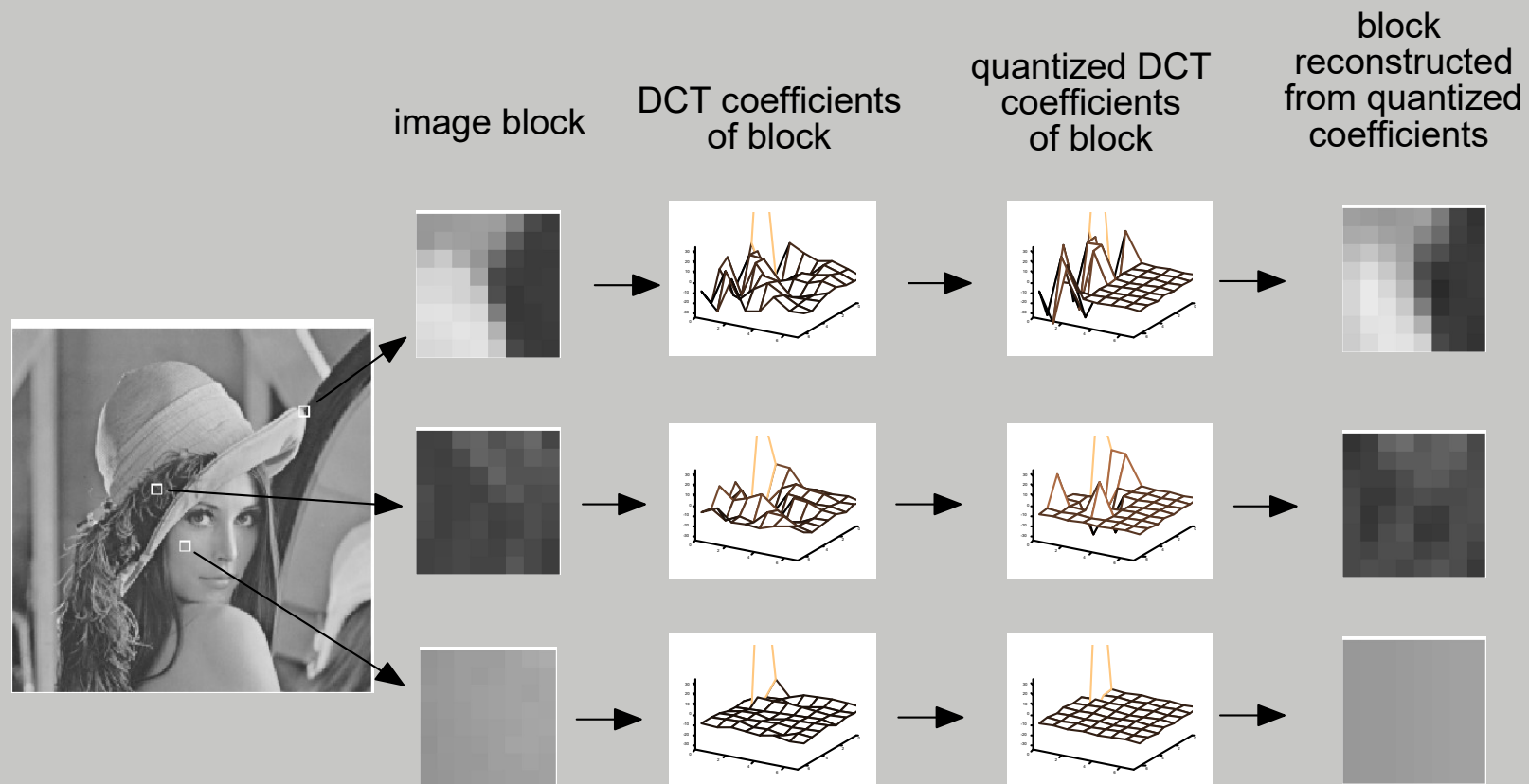
- ◆ N = number of frames (pictures) in a GOP
- ◆ M = number of B-frames between I- or P-frame + 1
- ◆ There is one I-frame for each GOP
- ◆ I-frame: intra coded only
- ◆ P-frame: forward prediction and MC
- ◆ B-frame: both forward and backward prediction and MC



DCT in Image Coding



DCT 变换



DCT量化的影响



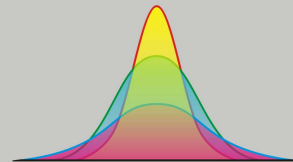
quantizer stepsize
for AC coefficients: 25



quantizer stepsize
for AC coefficients: 100



quantizer stepsize
for AC coefficients: 200





| | | | | | | | |
|-----|-----|-----|-----|-----|-----|-----|-----|
| 139 | 144 | 149 | 153 | 155 | 155 | 155 | 155 |
| 144 | 151 | 153 | 156 | 159 | 156 | 156 | 156 |
| 150 | 155 | 160 | 163 | 158 | 156 | 156 | 156 |
| 159 | 161 | 162 | 160 | 160 | 159 | 159 | 159 |
| 159 | 160 | 161 | 162 | 162 | 155 | 155 | 155 |
| 161 | 161 | 161 | 161 | 160 | 157 | 157 | 157 |
| 162 | 162 | 161 | 163 | 162 | 157 | 157 | 157 |
| 162 | 162 | 161 | 161 | 163 | 158 | 158 | 158 |

Original block



DCT

| | | | | | | | |
|-------|-------|-------|------|------|------|------|------|
| 235.6 | -1.0 | -12.1 | -5.2 | 2.1 | -1.7 | -2.7 | 1.3 |
| -22.6 | -17.5 | -6.2 | -3.2 | -2.9 | -0.1 | 0.4 | -1.2 |
| -10.9 | -9.3 | -1.6 | 1.5 | 0.2 | -0.9 | -0.6 | -0.1 |
| -7.1 | -1.9 | 0.2 | 1.5 | 0.9 | -0.1 | 0.0 | 0.3 |
| -0.6 | -0.8 | 1.5 | 1.6 | -0.1 | -0.7 | 0.6 | 1.3 |
| 1.8 | -0.2 | 1.6 | -0.3 | -0.8 | 1.5 | 1.0 | -1.0 |
| -1.3 | -0.4 | -0.3 | -1.5 | -0.5 | 1.7 | 1.1 | -0.8 |
| -2.6 | 1.6 | -3.8 | -1.8 | 1.9 | 1.2 | -0.6 | -0.4 |

Transformed block

| | | | | | | | |
|----|----|----|----|-----|-----|-----|-----|
| 16 | 11 | 10 | 16 | 24 | 40 | 51 | 61 |
| 12 | 12 | 14 | 19 | 26 | 58 | 60 | 55 |
| 14 | 13 | 16 | 24 | 40 | 57 | 69 | 56 |
| 14 | 17 | 22 | 29 | 51 | 87 | 80 | 62 |
| 18 | 22 | 37 | 56 | 68 | 109 | 103 | 77 |
| 24 | 35 | 55 | 64 | 81 | 104 | 113 | 92 |
| 49 | 64 | 78 | 87 | 103 | 121 | 120 | 101 |
| 72 | 92 | 95 | 98 | 112 | 100 | 103 | 99 |

Quantization matrix

Bit-stream



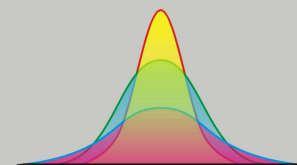
Entropy coding

15 0 -2 -1 -1 -1 0 ...



Zig-zag scan

| | | | | | | | |
|----|----|----|---|---|---|---|---|
| 15 | 0 | -1 | 0 | 0 | 0 | 0 | 0 |
| -2 | -1 | 0 | 0 | 0 | 0 | 0 | 0 |
| -1 | -1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

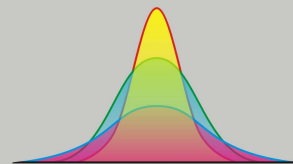
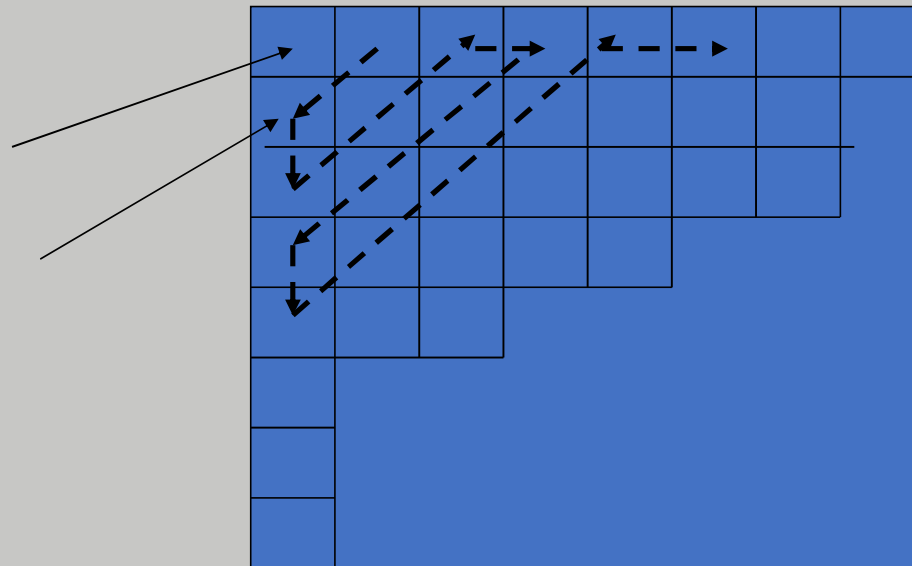


Zigzag 扫面

- 2D->1D

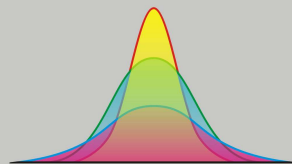
DC term

AC term

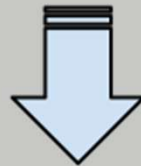
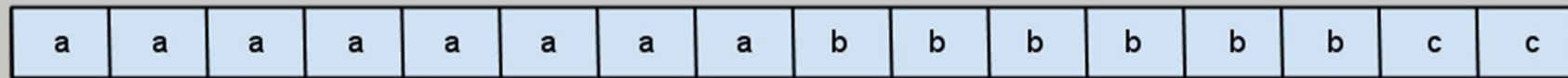


DPCM : Differential PCM

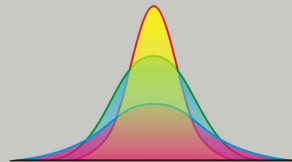
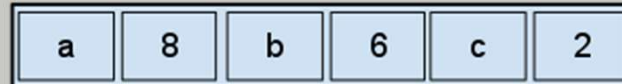
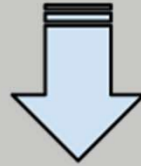
- 使用相近的字之间的差进行存储, 对于重复出现和或者相近变化不大的情况比较多时比较好
- 例如 'AAFFFFFFCCC'
 - PCM => '65,65,70,70,70,70,70,67,67,67' or '0,0,5,5,5,5,5,2,2,2'
 - DPCM => '0,0,5,0,0,0,0,-3,0,0'



Run-Length Coding



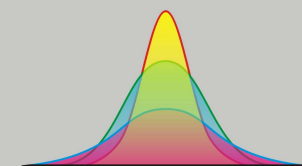
run-length encoding



Huffman Coding

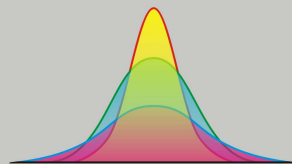
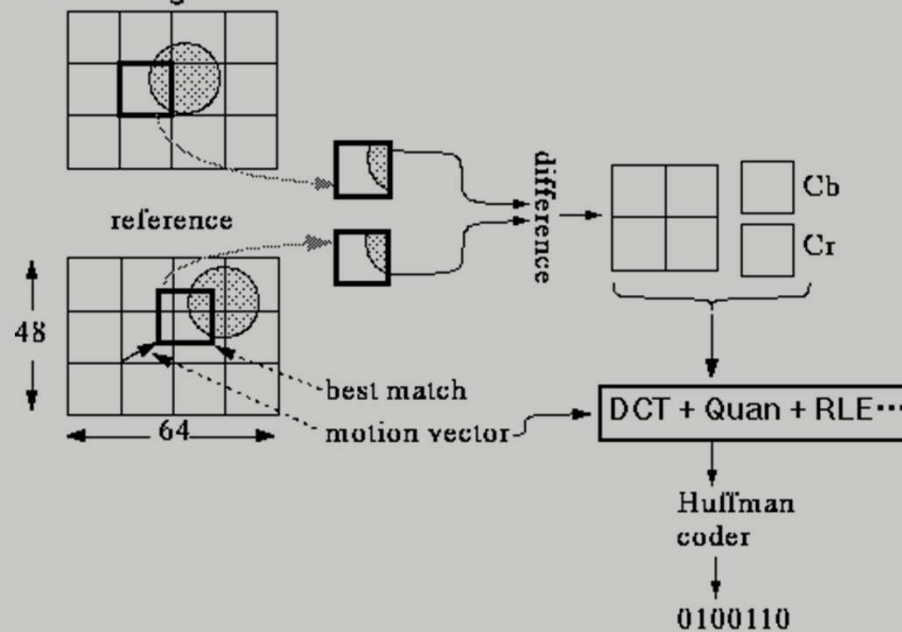
- 让出现最多的字(word)，用最小的(code)代替

| 例子 | 'A' | 'B' | 'C' | 'D' | | 平均长度 |
|----------------------|-----|-----|------|------|---|---|
| 出现几率 | 3/4 | 1/6 | 1/24 | 1/24 | | |
| Fixed-Length Code | 00 | 01 | 10 | 11 | → | $2*(3/4)+2*(1/6)+2*(1/24)+2*(1/24) = 2$ |
| Variable-Length Code | 0 | 10 | 110 | 111 | → | $1*(3/4)+2*(1/6)+3*(1/24)+3*(1/24) = 1.333$ |

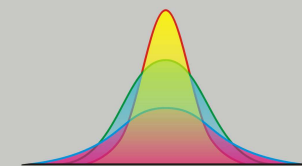
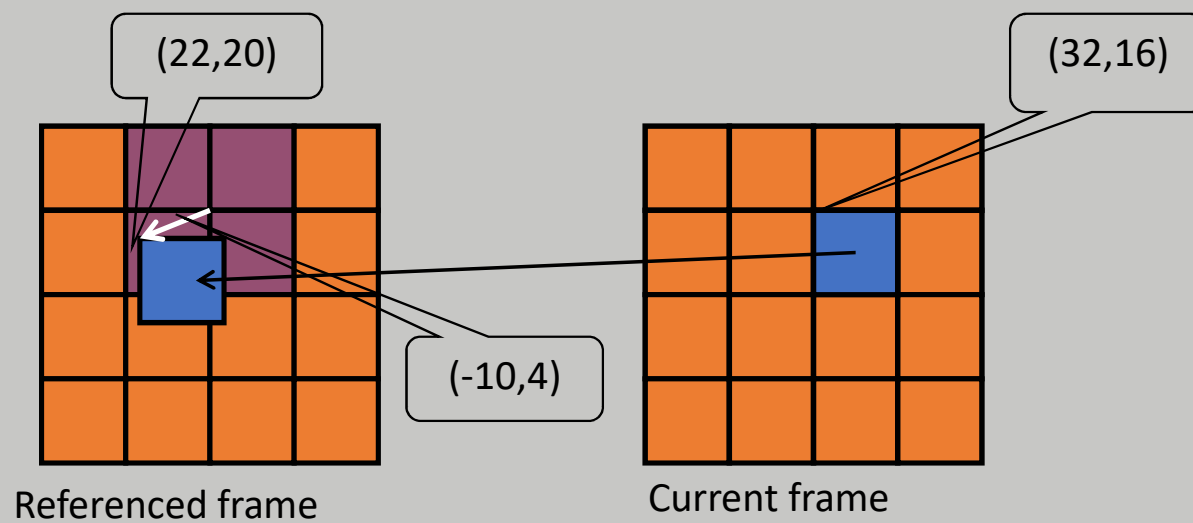


Motion prediction

- For motion prediction to work, we need to record the motion of every pixel. This can be done more efficiently using image blocks called “Macroblocks”
- The predicted macroblock and the actual image block are compared and the difference is encoded

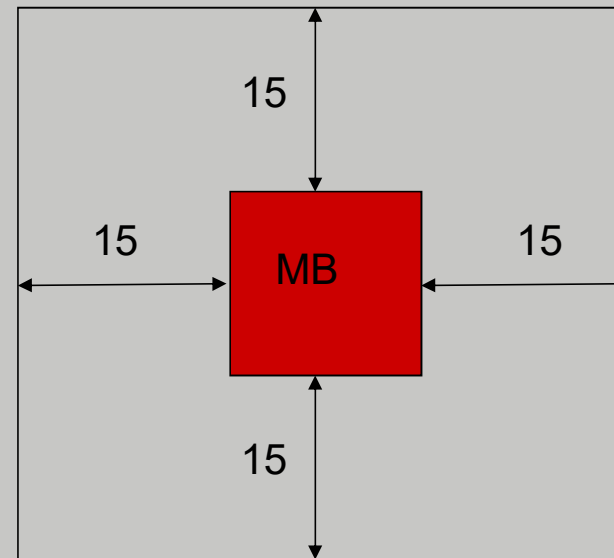
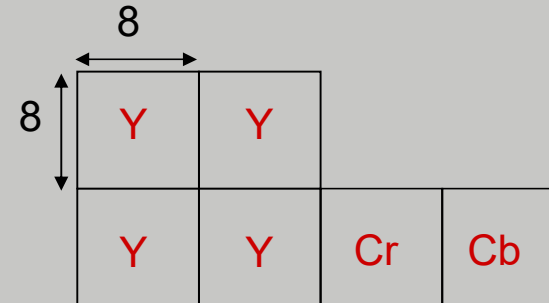


运动估计

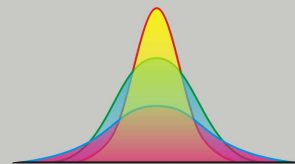


H.261 运动估计

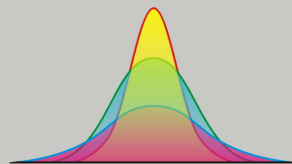
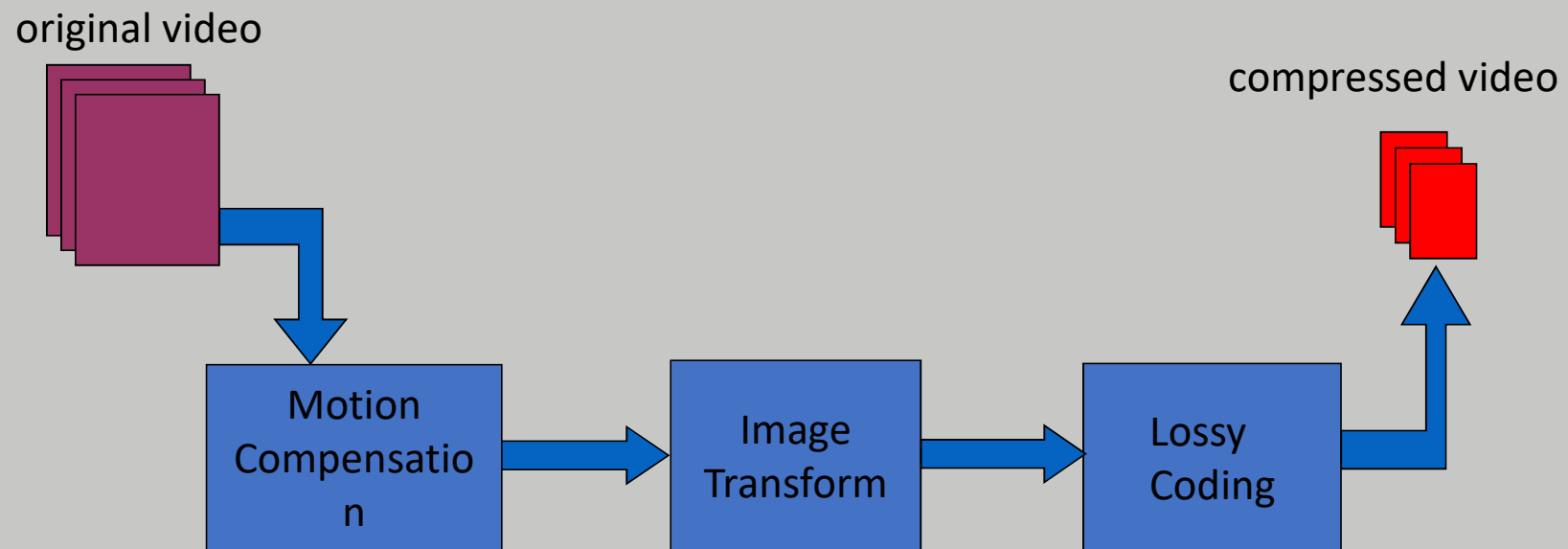
- Macro-block
 - Luminance: 16x16, four 8x8 blocks
 - Chrominance: two 8x8 blocks
 - Motion estimation only performed for luminance component
- Motion vector range
 - $[-15, 15]$



Search Area in Reference Frame

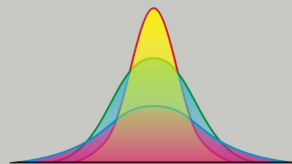


The H.263 Standard Coder

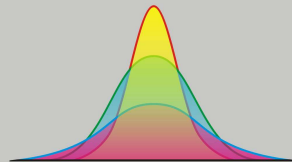
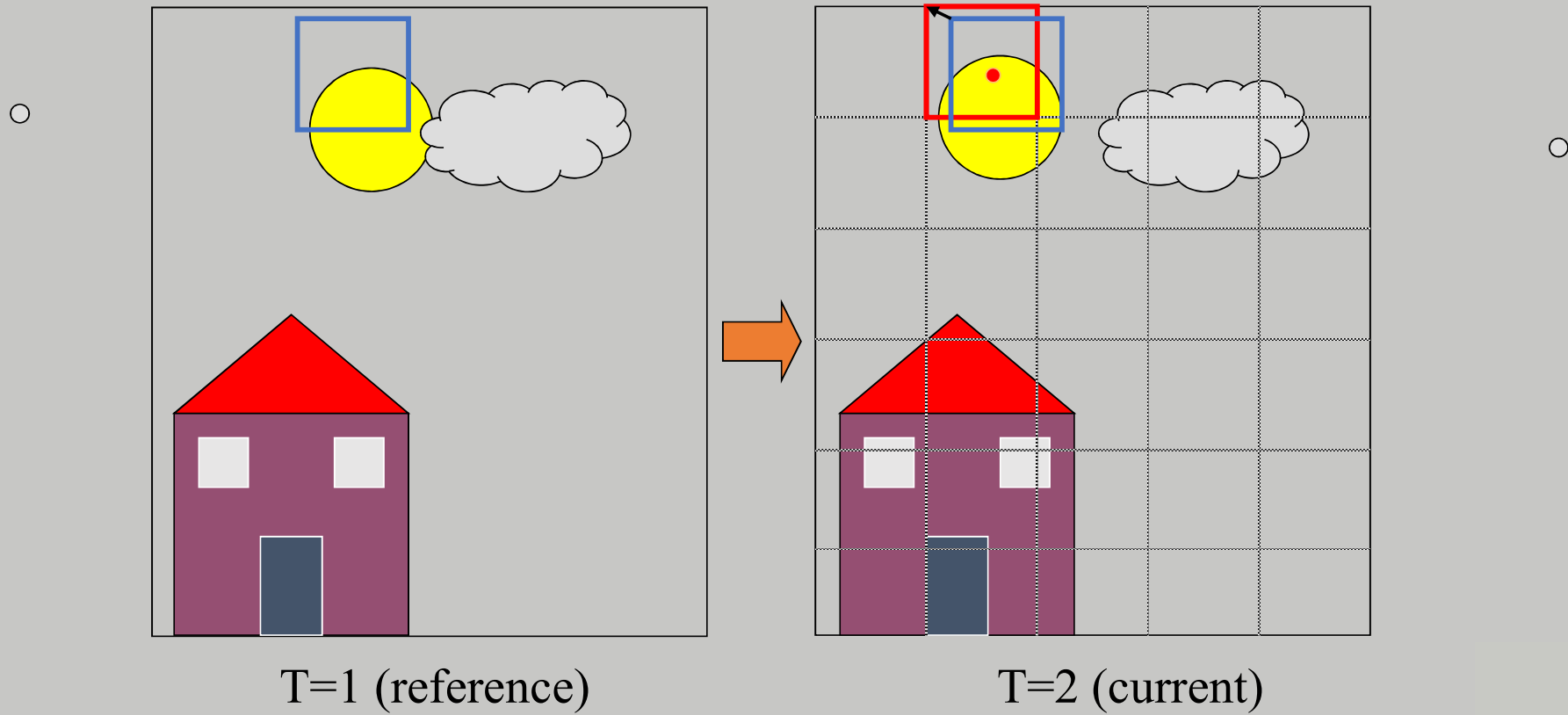


H.263运动补偿

- 图像分解成16X16的宏块
- 允许一个宏块中4个8×8亮度块各对应一个运动矢量，从而提高了预测精度
- 两个色度块的运动矢量则取这4个亮度块运动矢量的平均值
- 补偿时，使用重叠的块运动补偿，8×8亮度块的每个像素的补偿值由3个预测值加权平均得到

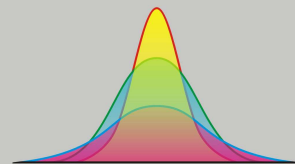


Motion Compensation Example

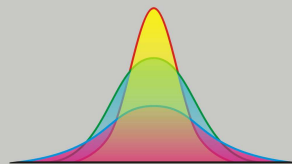
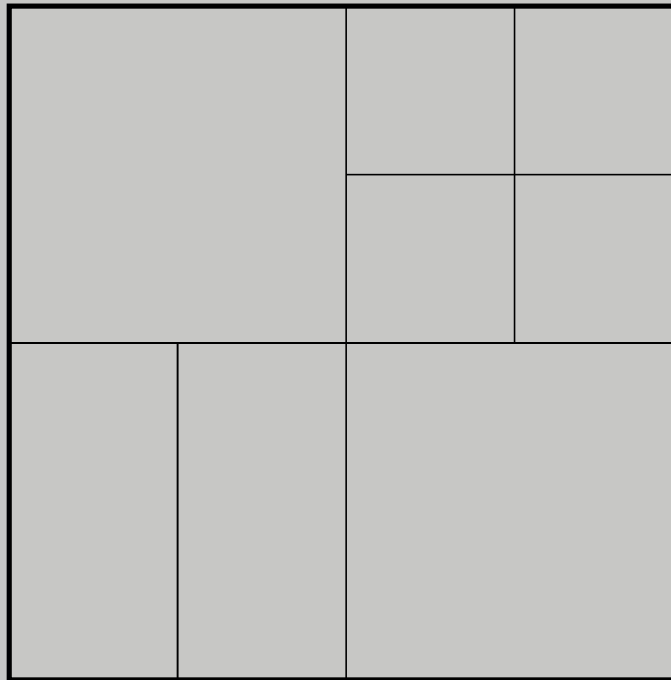


H.264 运动比较

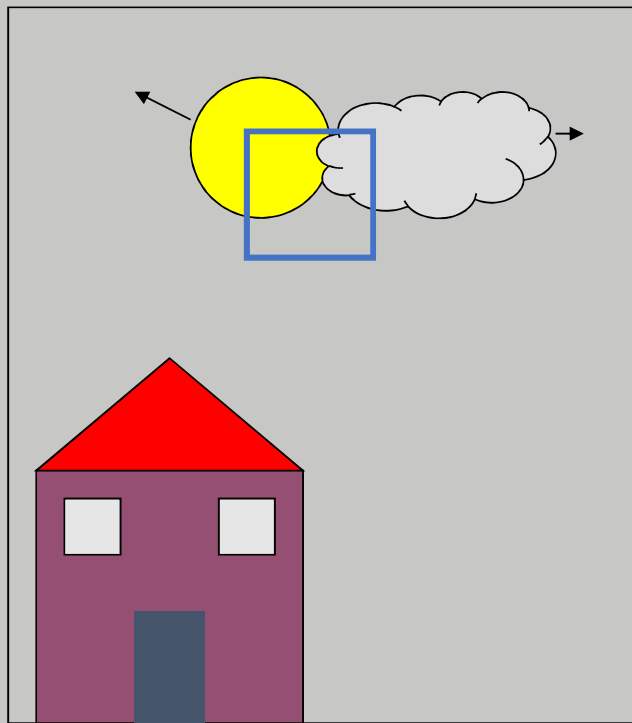
- $\frac{1}{4}$ 像素的精确运动比较
- 动态的 block-size:
 - 每个16X16的宏块能够再被分割
 - 每个子块能够分别进行运动评估
- 多重任意的参考帧
 - 对比(H.263) 的优质有之前或者 (MPEG)的前后方式.
- 抗模糊子像素插值



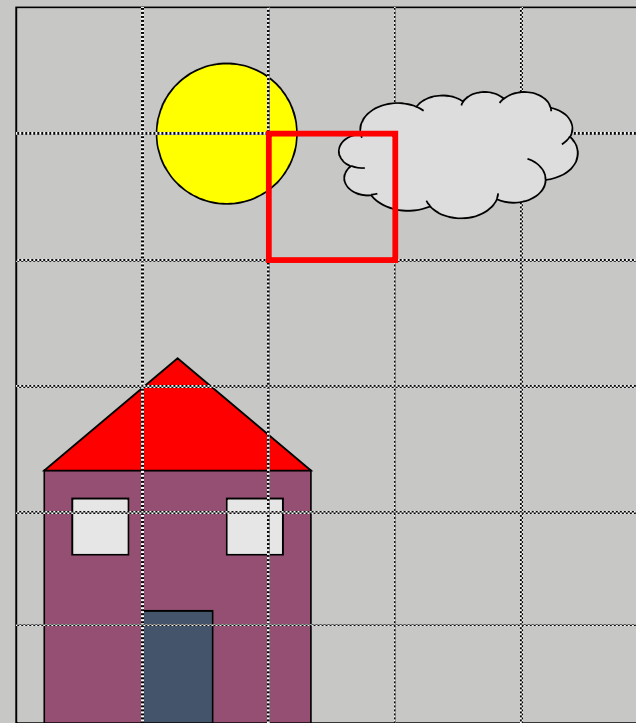
H.264 Variable Block Sizes



Motion Scale Example

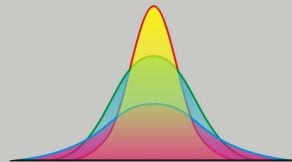


$T=1$

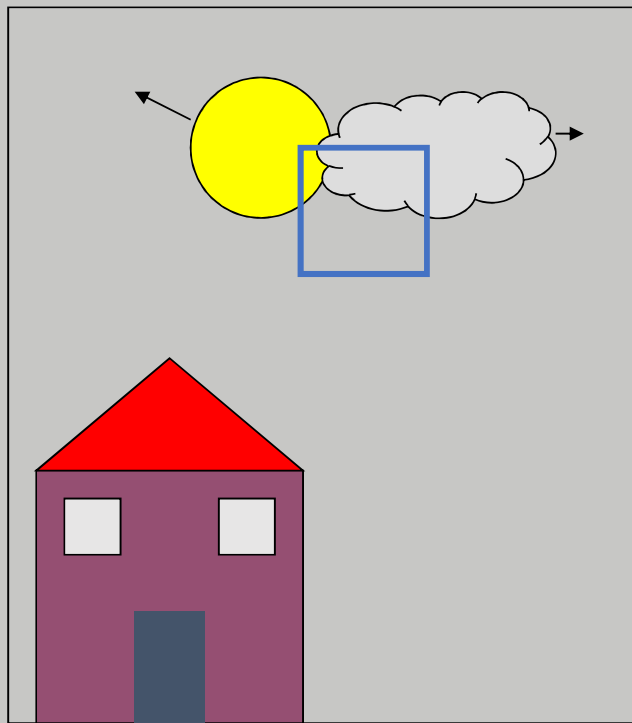


$T=2$

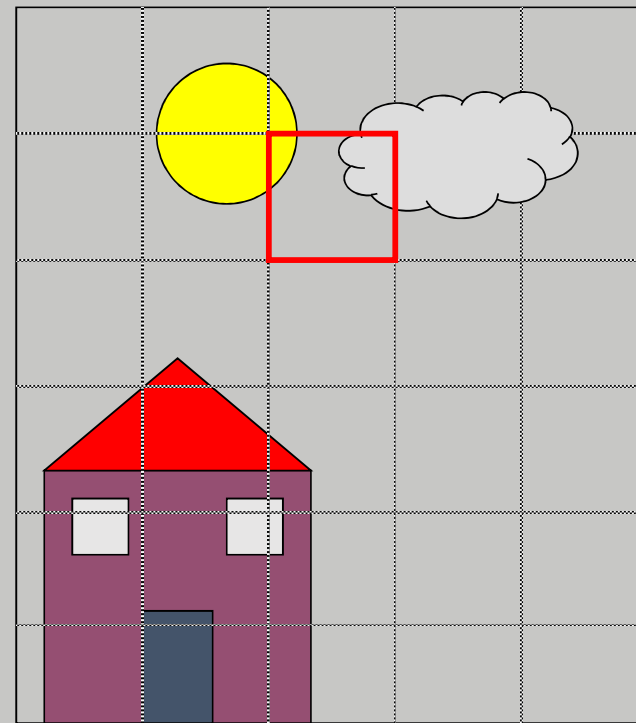
4/30/2018



Motion Scale Example

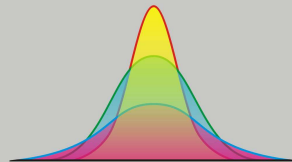


$T=1$

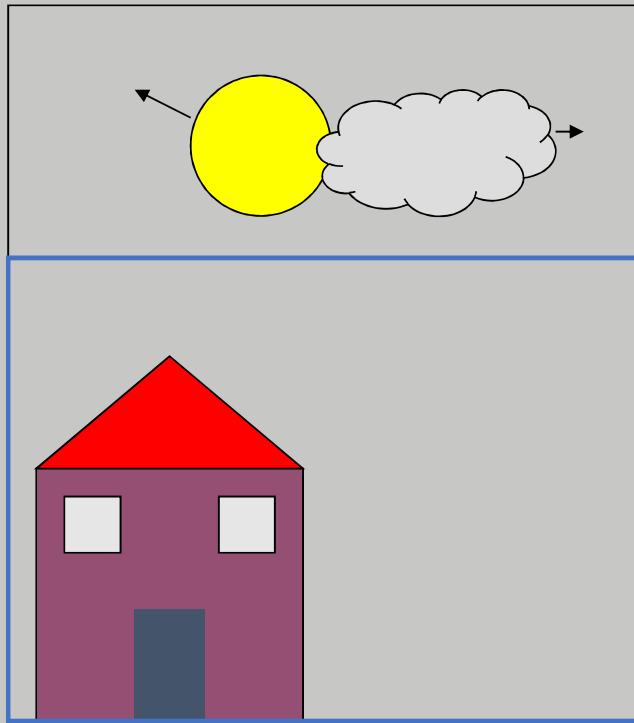


$T=2$

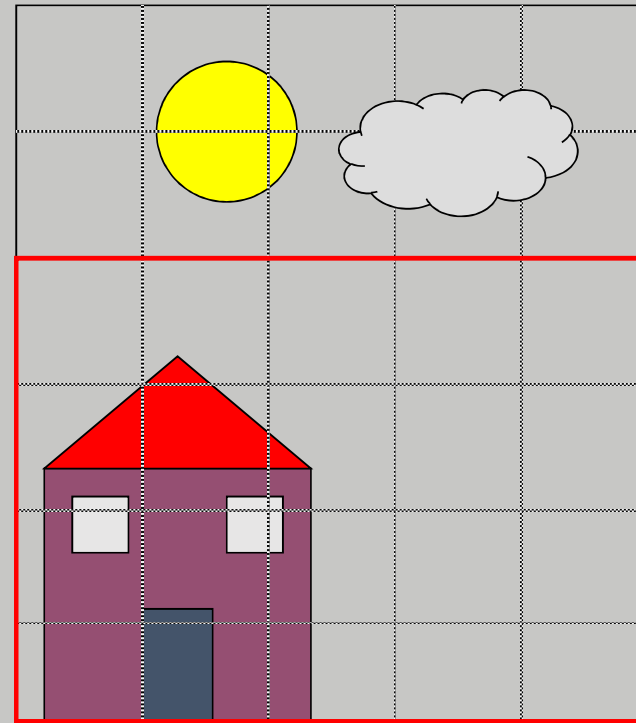
4/30/2018



Motion Scale Example

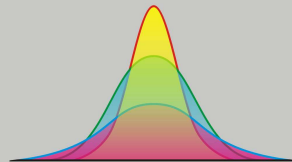


$T=1$



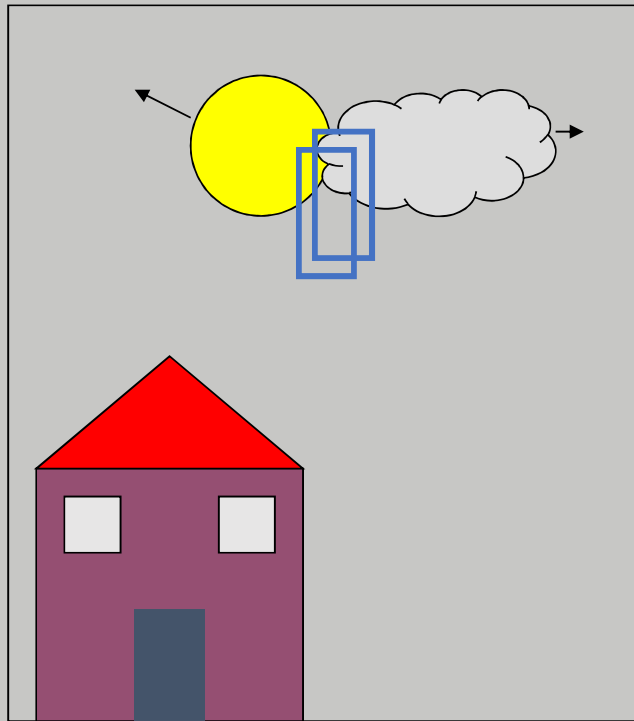
$T=2$

4/30/2018

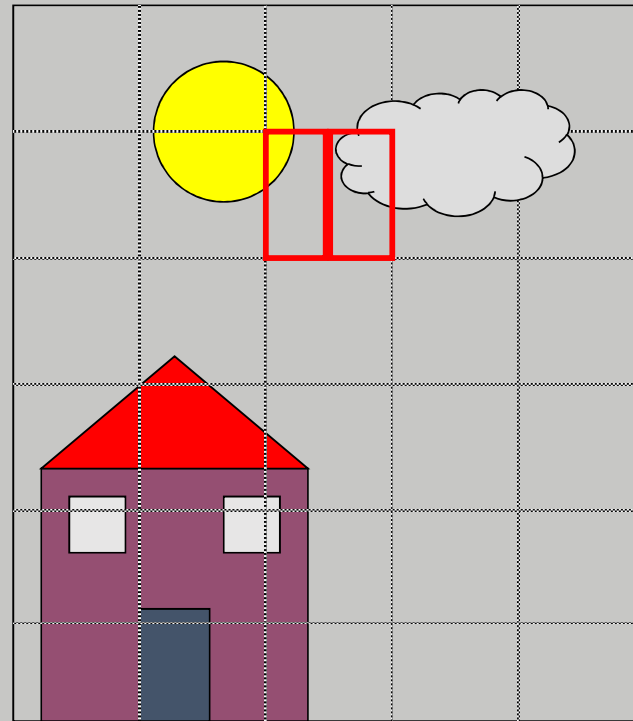


H.264 VBS Example

○

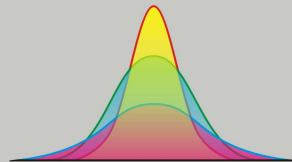


T=1



T=2

○



H.264的画质区别

H.264有四种画质级别，分别是BP、EP、MP、HP

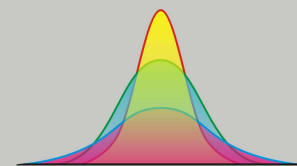
1、BP-Baseline Profile：基本画质。支持I/P 帧，只支持无交错(Progressive)和CAVLC;

2、EP-Extended profile：进阶画质。支持I/P/B/SP/SI 帧，只支持无交错(Progressive)和CAVLC;

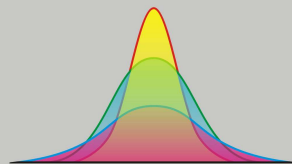
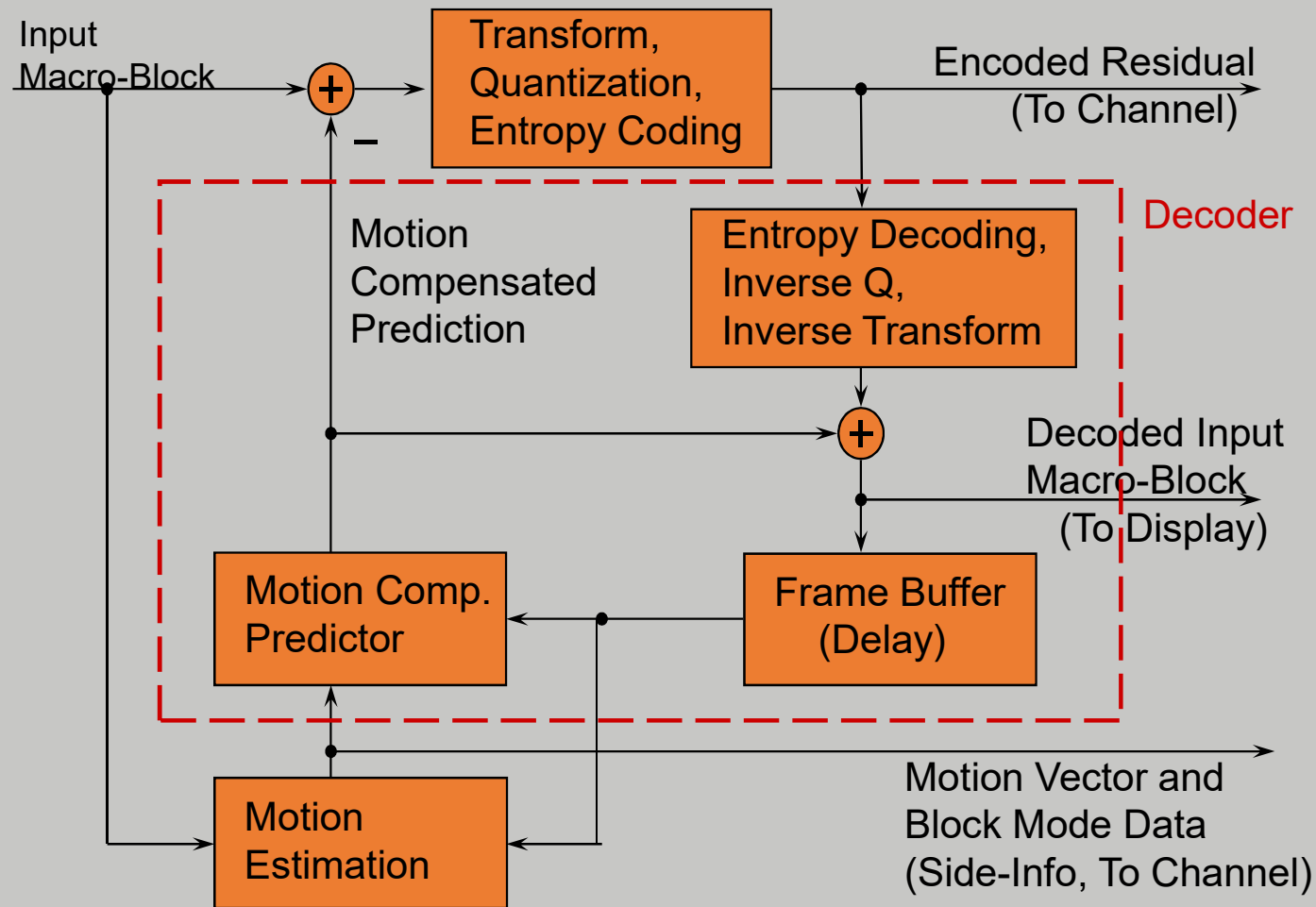
3、MP-Main profile：主流画质。提供I/P/B 帧，支持无交错(Progressive)和交错(Interlaced)，也支持CAVLC 和CABAC 的支持

4、HP-High profile：高级画质。在main Profile 的基础上增加了8x8内部预测、自定义量化、无损视频编码和更多的YUV 格式

在相同配置情况下，High profile (HP) 可以比Main profile (MP) 节省10%的码流量，比MPEG-2 MP节省60%的码流量，具有更好的编码性能。根据应用领域的不同，Baseline profile多应用于实时通信领域，Main profile多应用于流媒体领域，High profile则多应用于广电和存储领域。

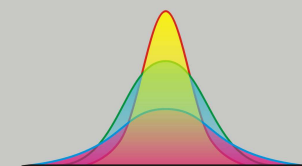


Hybrid MC-DCT Encoder



THANKS

本课程由 Eric Zhang 提供



大话成像之 数字成像系统 32 讲

内容目录

1. 数字成像系统介绍
2. CMOS image sensor基础
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6. 3A概述
7. 黑电平与线性化
8. Green Imbalance
9. 坏点消除
10. Vignetting与Color shading
11. SNR 与Raw Denoise
12. Dynamic Range与Tone Mapping
13. MTF与Demosaic
14. 色彩空间与色彩重建
15. Color Correction Matrix与3D LUT
16. Gamma与对比度增强
17. Sharpening
18. Color Space Conversion
19. 空域去噪
20. 时域去噪
21. Color Aberrance Correction and Depurple
22. ISP 的统计信息
23. 自动曝光
24. 自动白平衡
25. 自动对焦
26. 闪光灯
27. HDR
28. Exif 和DNG
29. Encoder
30. 图像防抖
31. 图像质量评价工具与方法
32. 画质调优

