Lecture 9 – Image Compression（图像压缩）

This lecture will cover:

– Fundamentals (基础知识)

- Coding Redundancy (编码冗余)
- Spatial and Temporal Redundancy（空间和时间冗余）
- Irrelevant Information（不相关信息）

– Measuring Image Information（信息量）

– Fidelity Criteria (保真度准则)

– Image Compression Model（图像压缩模型）

- Source coding (信源编码)
- Channel coding（信道编码）

– Image Formats, Containers and Compression Standards（图像格式、容器和压缩标准）

Fundamentals of Image Compression

- Coding Redundancy (编码冗余)
- Spatial and Temporal Redundancy（空间和时间冗余）
- Irrelevant Information（不相关信息）

Measuring Image Information（信息量）

- **Information Unit:**

$$I(E) = \log\frac{1}{P(E)} = -\log P(E)$$

Where $P(E)$ is the probability of a random event E.

- **Entropy (熵)**

$$H = -\sum_{j=1}^{J} P(a_j)\log P(a_j)$$

Calculate from Histogram

$$\tilde{H} = -\sum_{k=0}^{L-1} p_r(r_k)\log_2 p_r(r_k)$$

Fidelity Criteria (保真度准则)

Objective Fidelity Criteria (客观保真度准则)

- **Root Mean Square Error (均方根误差)**

$$e_{\text{rms}} = \left\{ \frac{1}{MN} \sum_{x=0}^{M-1} \sum_{y-0}^{N-1} \left[\hat{f}(x,y) - f(x,y) \right]^2 \right\}^{1/2}$$

Where $f(x,y)$ is the original image, and $\hat{f}(x,y)$ is an approximation.

- **Mean-square Signal-to-noise ratio (均方信噪比)**

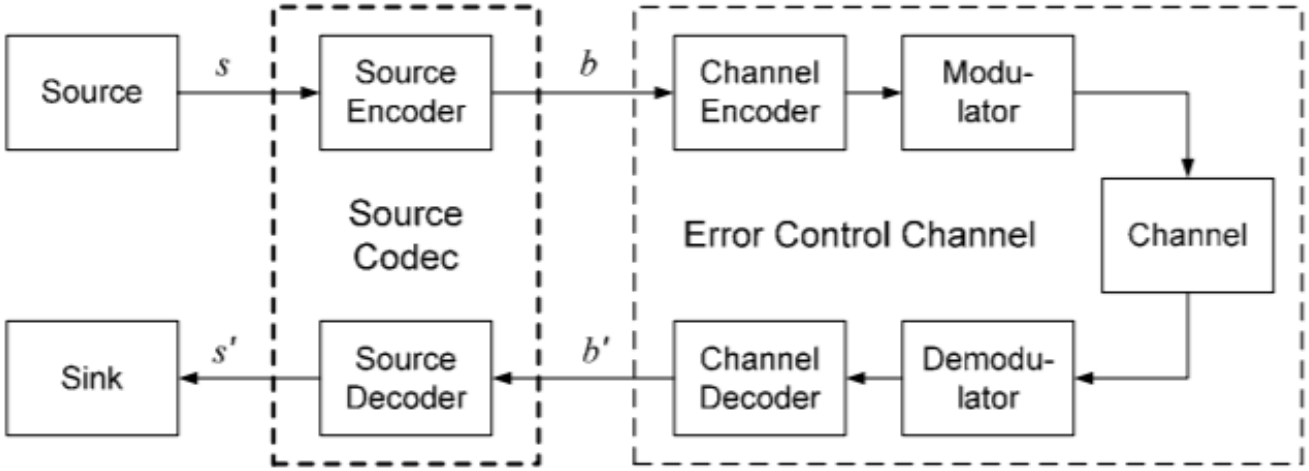
$$\text{SNR}_{\text{ms}} = \frac{\sum_{x=0}^{M-1} \sum_{y-0}^{N-1} [f(x,y)]^2}{\sum_{x=0}^{M-1} \sum_{y-0}^{N-1} \left[\hat{f}(x,y) - f(x,y) \right]^2}$$

Fidelity Criteria (保真度准则)

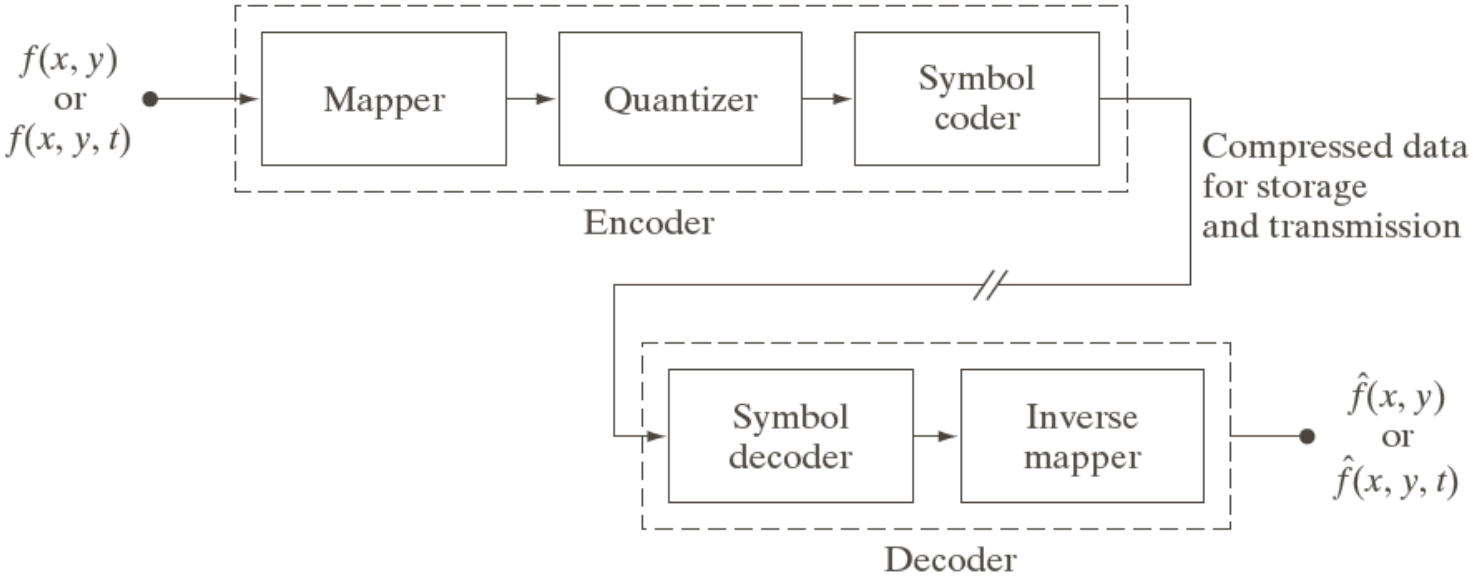
Subjective Fidelity Criteria (主观保真度准则)

Value	Rating	Description
1	Excellent	An image of extremely high quality, as good as you could desire.
2	Fine	An image of high quality, providing enjoyable viewing. Interference is not objectionable.
3	Passable	An image of acceptable quality. Interference is not objectionable.
4	Marginal	An image of poor quality; you wish you could improve it. Interference is somewhat objectionable.
5	Inferior	A very poor image, but you could watch it. Objectionable interference is definitely present.
6	Unusable	An image so bad that you could not watch it.

Image Compression Model（图像压缩模型）



Source coding (信源编码)



Channel coding（信道编码）

Hamming Code

For a 4-bit binary number $b_3b_2b_1b_0$, define the 7-bit code word as

$$h_1 = b_3 \oplus b_2 \oplus b_0 \qquad h_2 = b_3 \oplus b_1 \oplus b_0 \qquad h_4 = b_2 \oplus b_1 \oplus b_0$$

$$h_3 = b_3 \qquad h_5 = b_2 \qquad h_6 = b_1 \qquad h_7 = \oplus b_0$$

Parity (奇偶校验)

$$c_1 = h_1 \oplus h_3 \oplus h_5 \oplus h_7$$

$$c_2 = h_2 \oplus h_3 \oplus h_6 \oplus h_7$$

$$c_4 = h_4 \oplus h_5 \oplus h_6 \oplus h_7$$

Image Formats, Containers and Compression Standards