

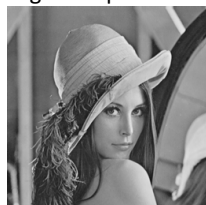
## 7/7 画像信号処理特論

### Schedule

- 5/12 "Hello World!" of image processing
- 5/19 Image filtering
- 5/26 Binarization
- 6/2 (Prof. Tehrani)
- 6/9 (Prof. Tehrani)
- 6/16 (Prof. Tehrani)
- 6/23 Histogram ← 1<sup>st</sup> report deadline
- 6/30 Discrete Cosine Transform
- 7/7 JPEG
- 7/14 (Prof. Fujii)
- 7/21 (Prof. Fujii) ← 2<sup>nd</sup> report deadline

### Today's issue

- Image Compression



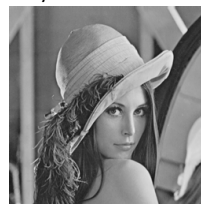
Original  
(65,551 byte)



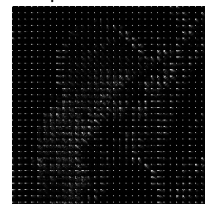
JPEG Compressed  
(7,365 byte)

### Today's issue

- Discrete cosine transform (DCT)
  - key to understand JPEG compression

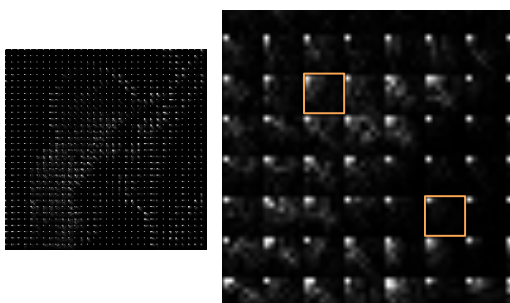


Input



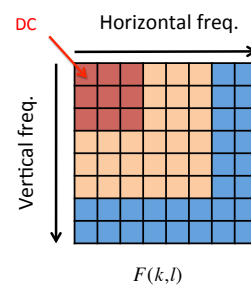
DCT coefficients

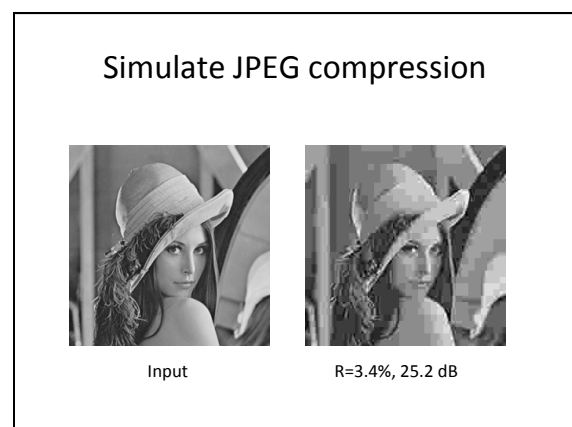
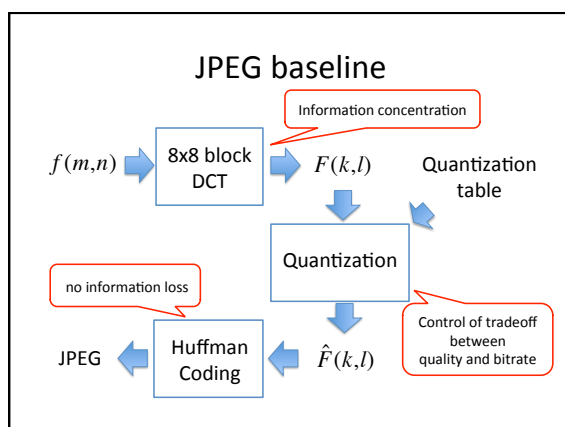
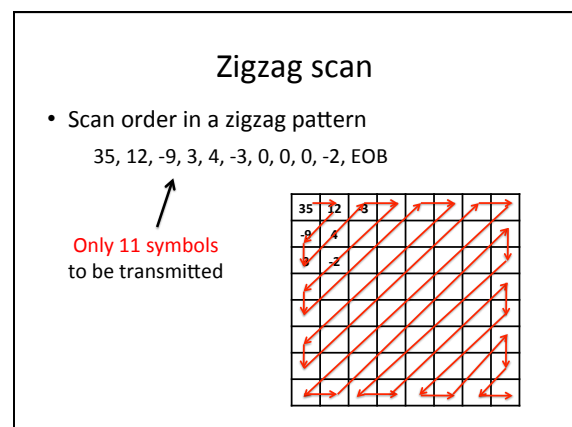
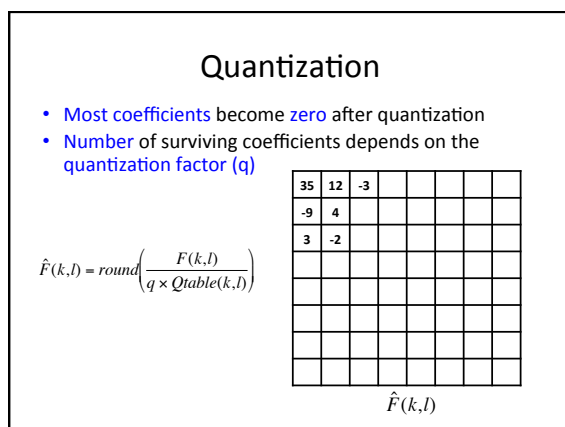
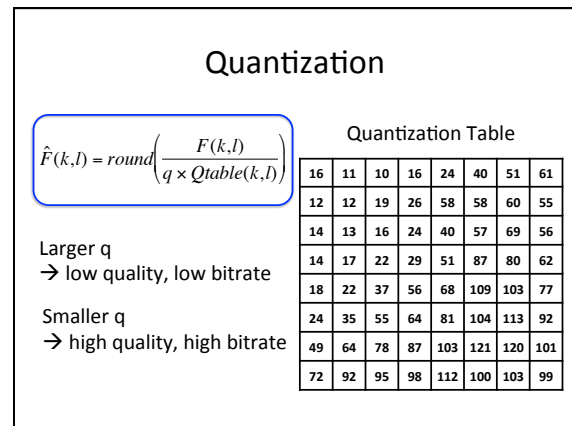
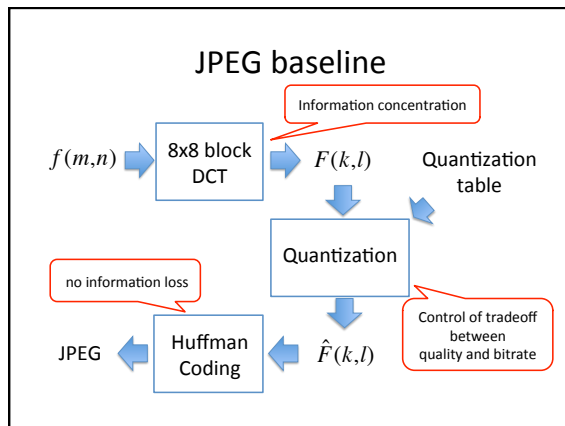
### Close look at DCT coefficients



### Detail of Frequency representation

- Coefficients are **real** values
- Most of the energy **concentrates** in the **low frequencies**





### Simulate JPEG compression



Input



R=8.6%, 30.3 dB

### Simulate JPEG compression



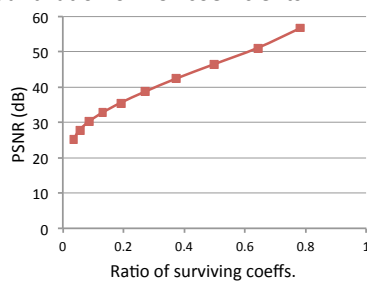
Input



R=19.0%, 35.5 dB

### Simulate JPEG compression

- Quantization of DCT coefficients



### Exercises

- Implement:
  - Quantization of DCT coefficients using a scale factor (q) and the quantization table
  - Image reconstruction from quantized DCT coefficients
- Observe the reconstructed images with various quantization levels
- Draw a trade-off curve between the compression ratio and quality (PSNR)

### Image quality metric

- Compression ratio

$$= \frac{\text{\# of nonzero DCT coefficients after quantization}}{\text{\# of pixels}}$$

- Image quality: PSNR (Peak signal to noise ratio)

$$MSE = \frac{1}{WH} \sum_{x=0}^{W-1} \sum_{y=0}^{H-1} (f(x,y) - g(x,y))^2$$

$$PSNR = 10 \log_{10} \left( \frac{255^2}{MSE} \right) \text{ [dB]}$$