图像与视频处理
Image and Video Processing

School of Computer Science &Technology, BIT
Prof. Zhao Qingjie(赵清杰)
zhaoqj@bit.edu.cn

- Introduction
- Basic Gray-Level Image Processing
- Basic Binary Image Processing
- Image Fourier Analysis
- Linear Filtering
- Nonlinear Filtering
- Image Processing using Deep Learning
- Morphological Filtering
- Wavelet Denoising
- Image Restoration
- Image and Video Compression
- Applications

Section I: Introduction

- ***Digital images*** and ***digital video*** are, respectively, pictures and movies that have been converted into a computer-readable binary format consisting of logical Os and 1s. Usually, an **image** is a still picture that does not change with time, whereas a **video** evolves with time and generally contains moving and/or changing objects.
- ***Digital images or video processing***

Image Processing Applications:

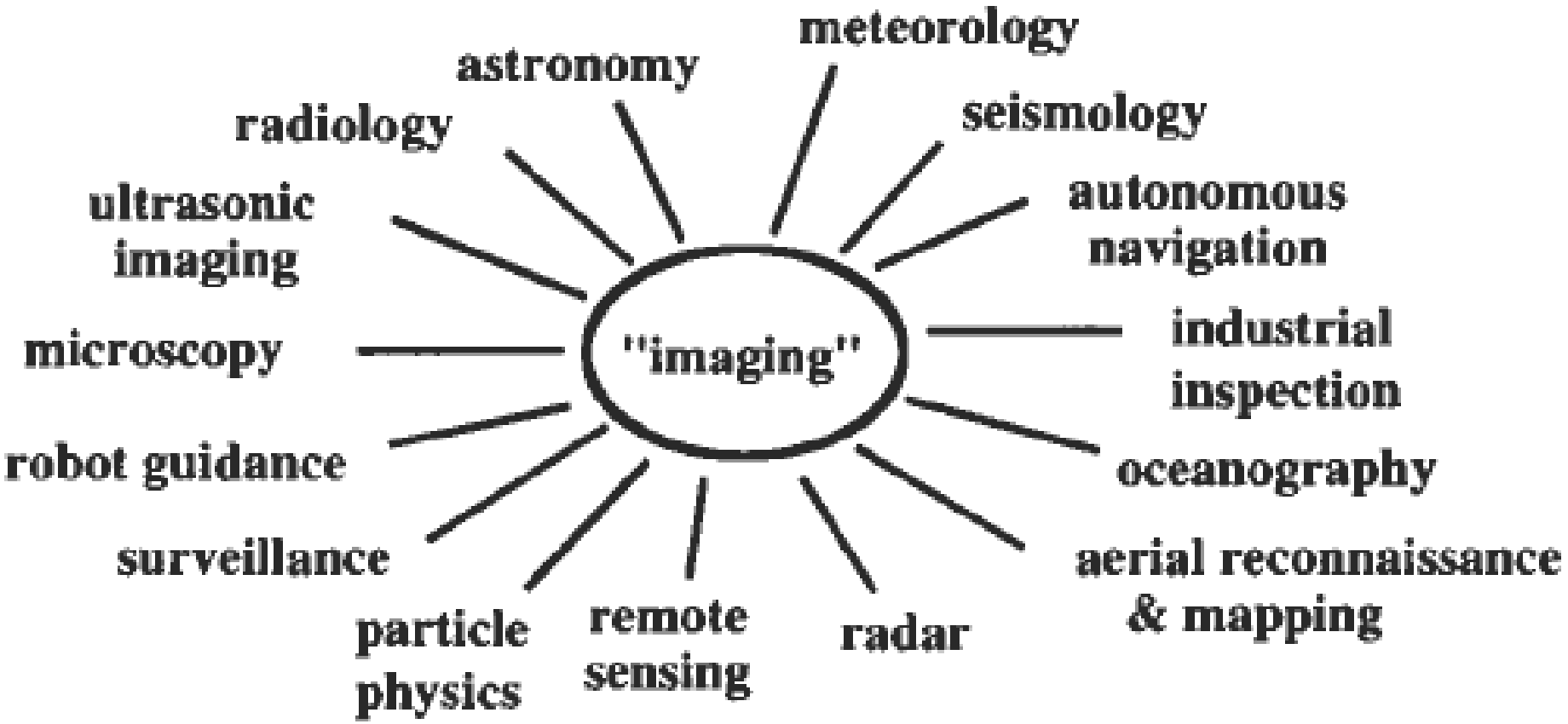
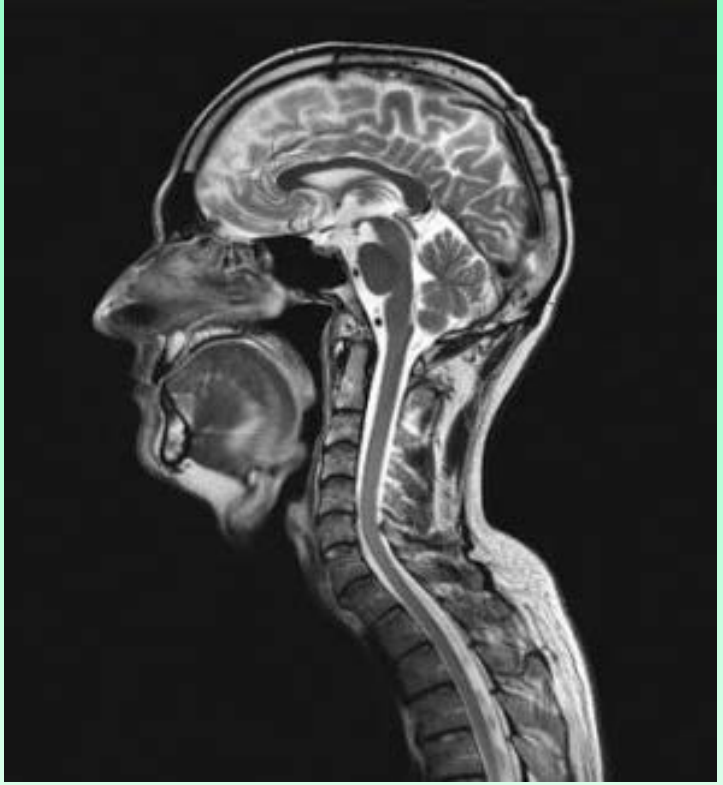
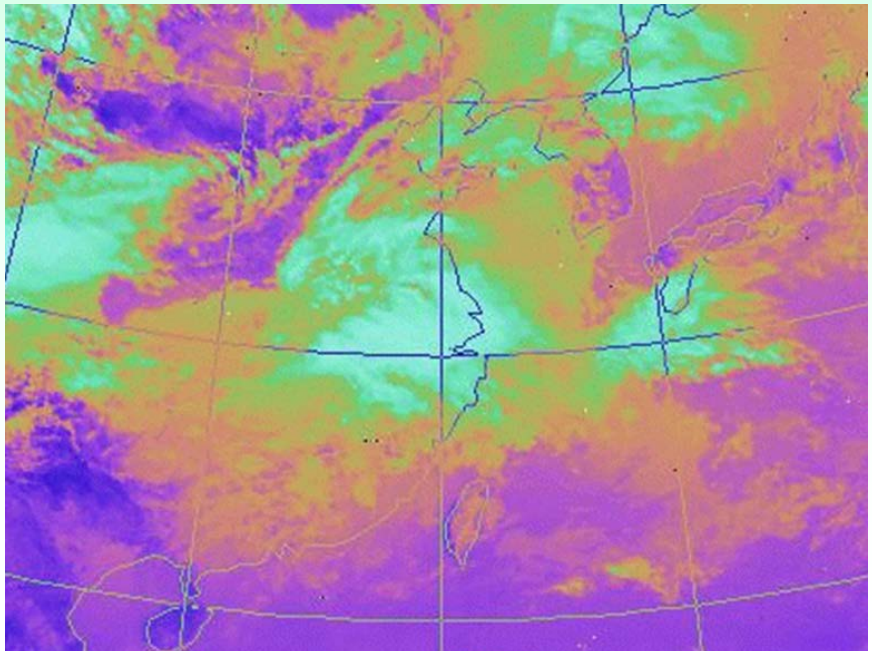


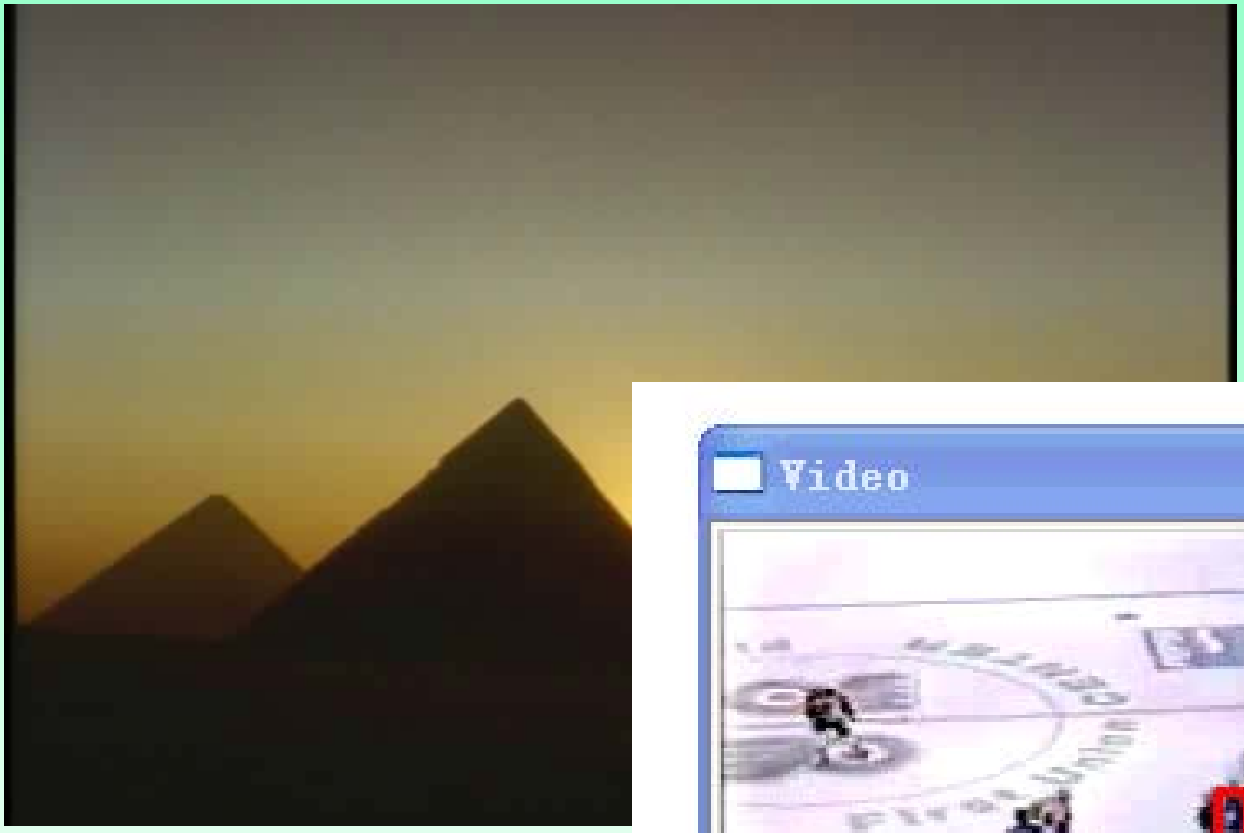
FIGURE 1 Part of the universe of image processing applications.

宣传娱乐

冰岛火山喷发 雷达图犹如怒吼








Video

- Types, Scale, Dimension
- Digitization of Images
- Sampled Images, Quantized Images
- Color Images
- Size of Image Data
- Digital Video
- Sampled Video
- Video Transmission

Types of Images

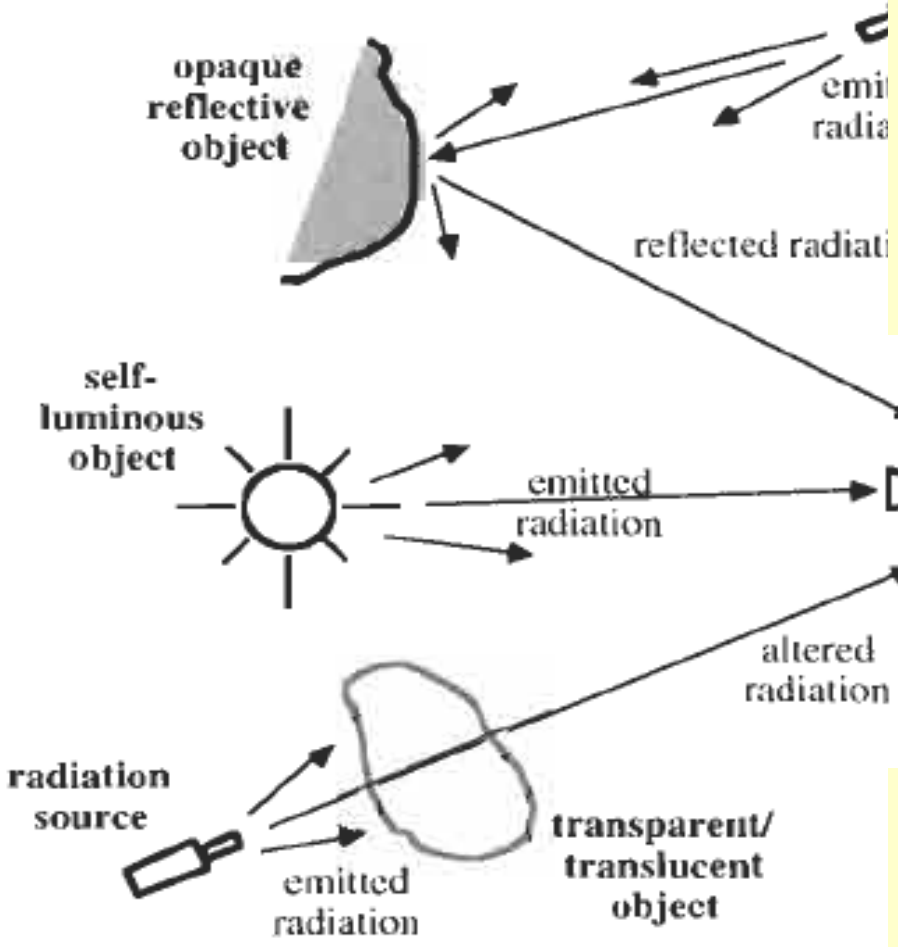
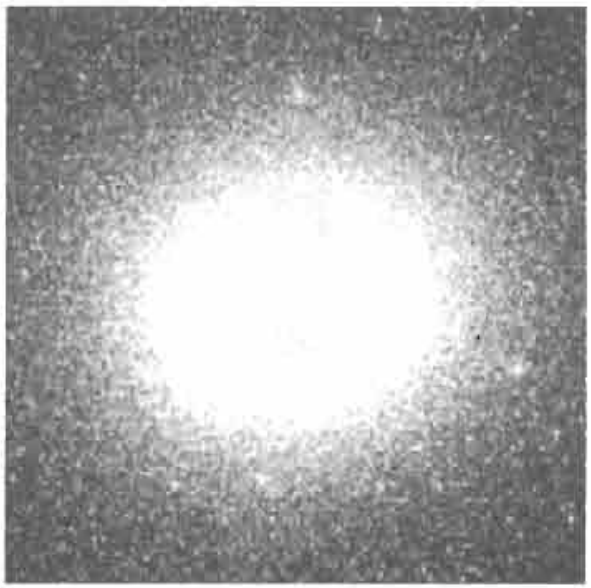


FIGURE 3 Recording the various types of intera

Reflection images sense radiation that has been reflected from the surfaces of objects. The information extracted is primarily an object's shape, texture, color, reflectivity, …--most visible optical images， radar images, sonar images, electron microscope images.

Emission images ： the objects being imaged are self-luminous. The information may reveal the internal structure of an object. --thermal or infrared images, MRI images

Absorption images yield information about the internal structure of objects. The radiation passes through objects and is absorbed or partially absorbed. --X-ray images, certain types of sonic images.



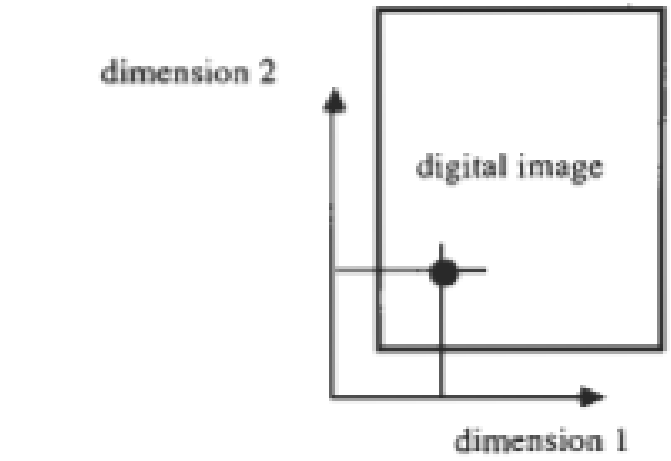
Scale of Images

- We are able to image from the grandest scale to the minutest scales, over a range of 40 orders of magnitude.



Dimension of Images

- The dimension **of** a signal is the number of coordinates that are required to index a given point in the image.
- Digital images and video is that they are *multidimensional signals*, meaning that they are functions of more than a single variable.



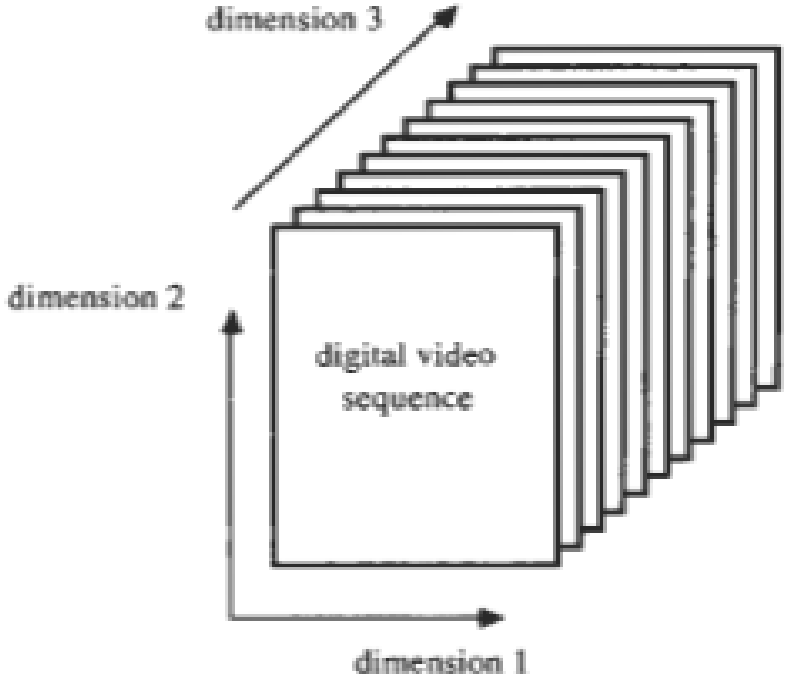


FIGURE 5 The dimensionality of images and video.

Digitization of Images

- The environment around us exists, at any reasonable scale of observation, in a space/time continuum.
  - The signal exists on a continuous (space/time) domain.
  - Its values come from a continuum of possibilities.
- The image or video signal must be converted into a computer readable digital format. (A/D)
  - The signal is defined on a discrete (space/time) domain.
  - Its values are from a discrete set of possibilities.

Sampled Images

- ***Sampling*** is the process of converting a continuous-space (or continuous-space/time) signal into a discrete-space (or discrete-space/time) signal.

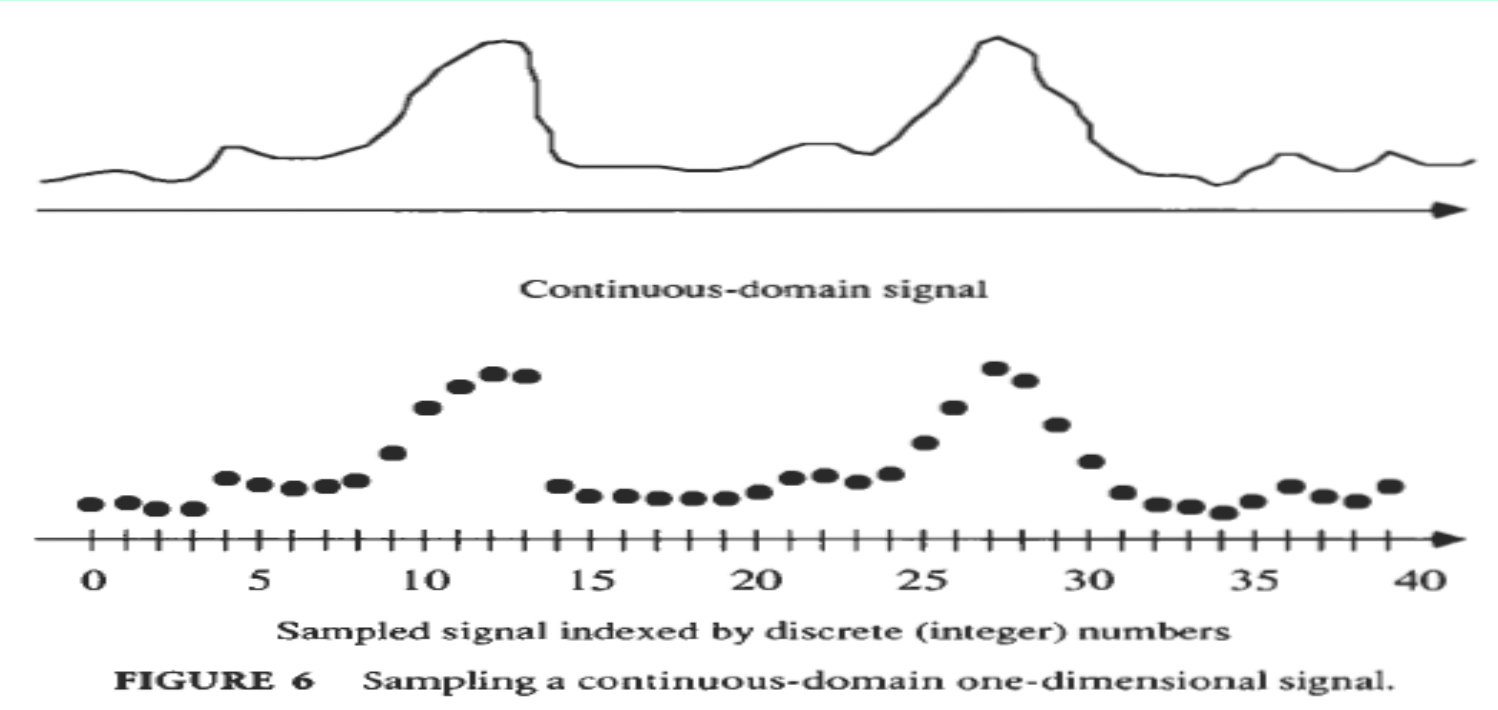


FIGURE 6 Sampling a continuous-domain one-dimensional signal.

- The number of rows and columns in a sampled image is also often selected to be a power of **2.**
  - to simplify computer addressing of the samples
  - to make algorithms, such as discrete Fourier transforms, efficient
- Images are nearly always rectangular

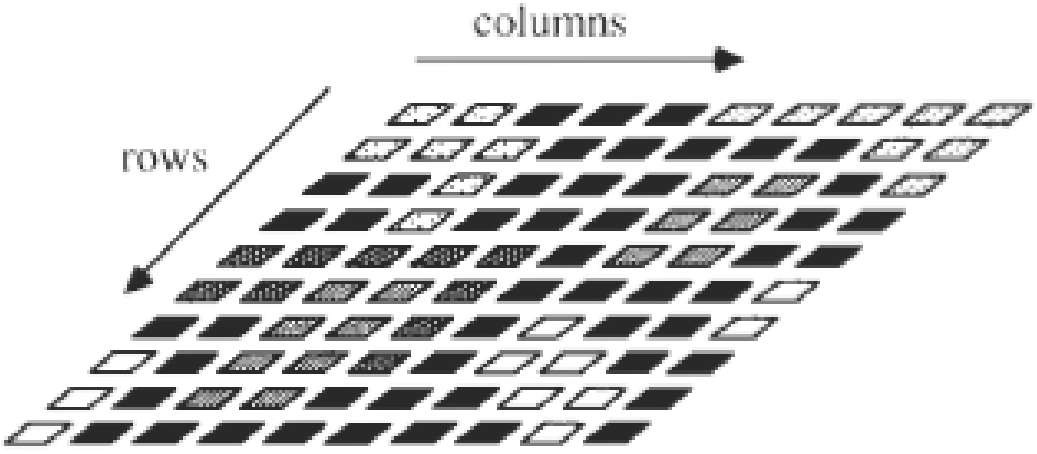


FIGURE 7 Depiction of a very small (10 × 10) piece of an image array.

pixel

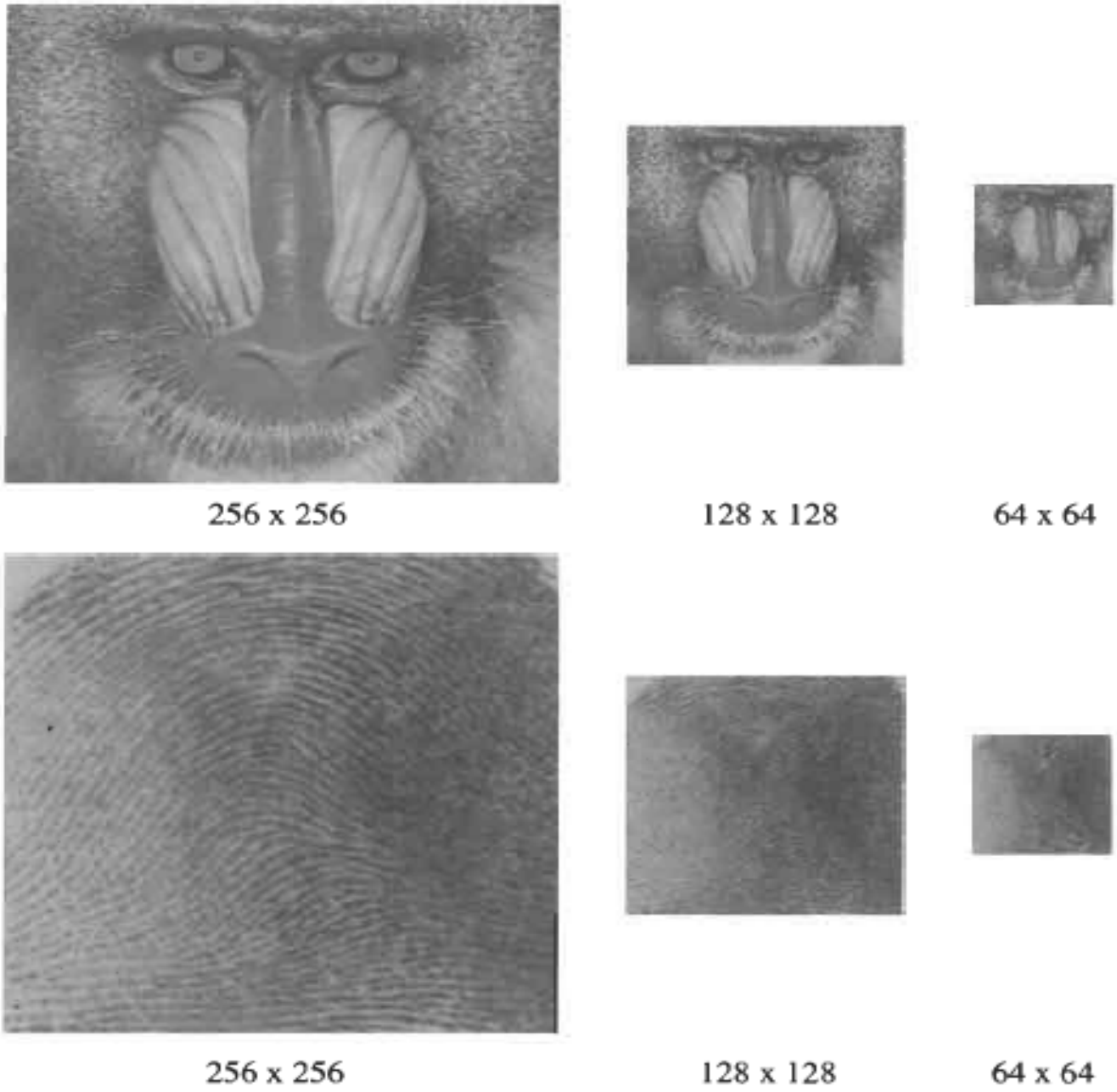
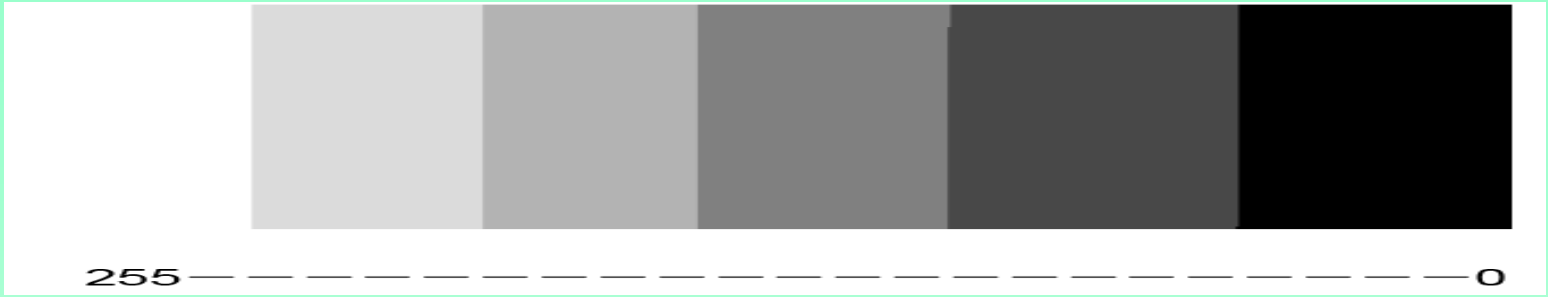


FIGURE 8 Examples of the visual effect of different image sampling densities.

Quantized Images

- **Quantization** is the process of converting a continuous-valued image, which has a continuous range (set of values that it can take), into a discrete-valued image, which has a discrete range.
- The gray level of a quantized image pixel is one of a finite set of numbers, which is the **gray level range (0, 2^B-1)**. B=1(binary images); B=8, Each gray level occupies a byte, 8-bit depths, and color images (Multivalued images) require **24** bits per pixel.



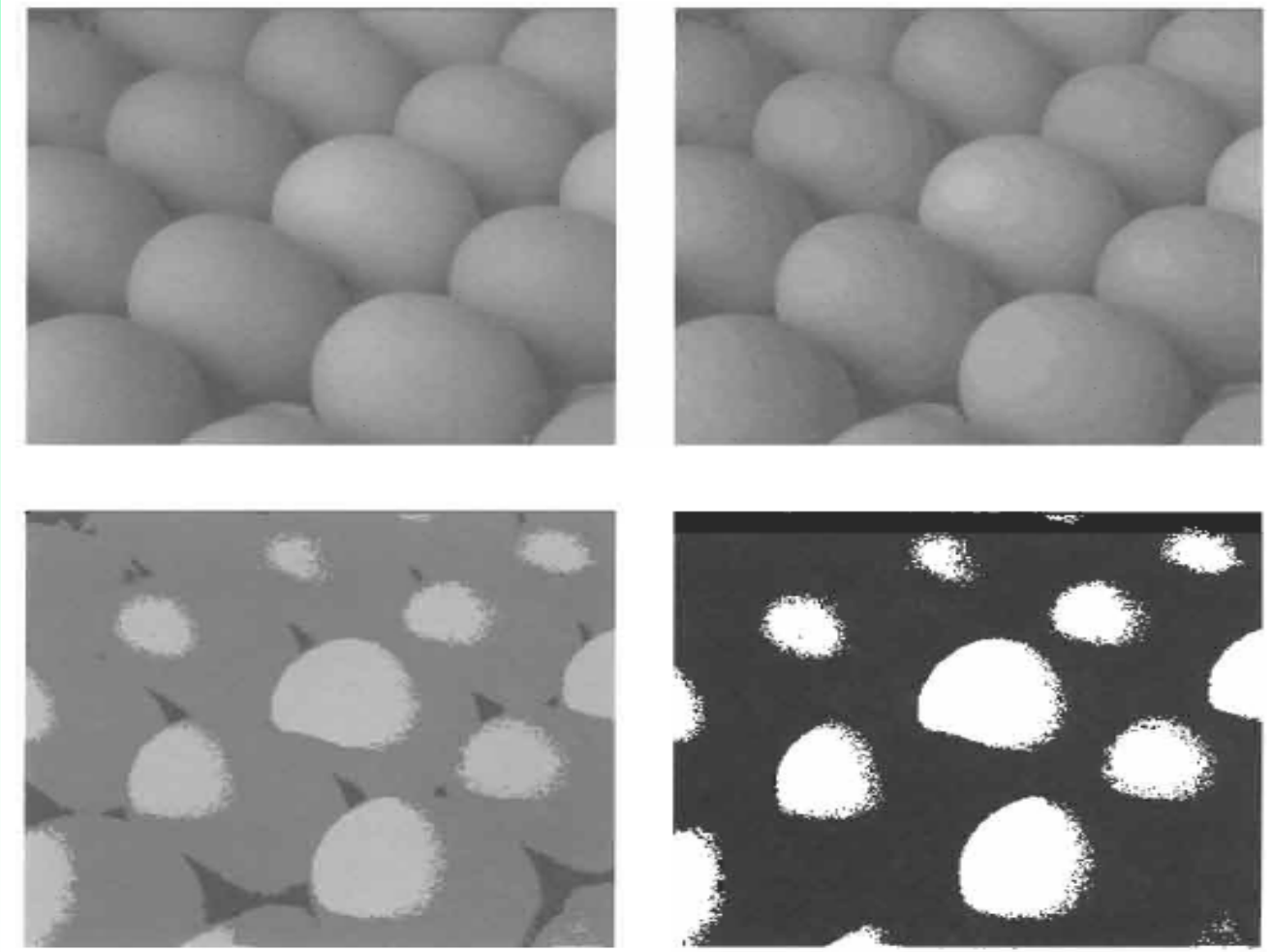


FIGURE 11 Quantization of the 256 × 256 image "eggs." Clockwise from upper left: 8, 4, 2, and 1 bits per pixel.

Color Images

- RGB(Red, Green, Blue), color cameras, display systems
- YIQ(luminance, in-phase chromatic, quadratic chromatic), broadcast television

$$\begin{bmatrix} Y \\ I \\ Q \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ 0.596 & -0.275 & -0.321 \\ 0.212 & -0.523 & 0.311 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

Size of Image Data

- The storage required for a single monochromatic digital **still** image that has (row x column) dimensions *N* * M and B bits of gray-level resolution is *N* * *M* * *B* bits.
- If the image is vector valued, e.g., color, then the data volume is multiplied by the vector dimension.

TABLE 1 Data-volume requirements for digital still images of various sizes, bit depths, and vector dimension

Spatial Dimensions	Pixel Resolution (bits)	Image Type	Data Volume (bytes)
128 × 128	1	Monochromatic	2,048
256 × 256	1	Monochromatic	8,192
512 × 512	1	Monochromatic	32,768
1024 × 1024	1	Monochromatic	131,072
128 × 128	8	Monochromatic	16,384
256 × 256	8	Monochromatic	65,536
512 × 512	8	Monochromatic	262,144
1024 × 1024	8	Monochromatic	1,048,576
128 × 128	3	Trichromatic	6,144
256 × 256	3	Trichromatic	24,576
512 × 512	3	Trichromatic	98,304
1024 × 1024	3	Trichromatic	393,216
128 × 128	24	Trichromatic	49,152
256 × 256	24	Trichromatic	196,608
512 × 512	24	Trichromatic	786,432
1024 × 1024	24	Trichromatic	3,145,728

- Standard video systems display visual information at a rate of **30 images/s** for reasons related to human visual latency.
- **A 512 * 512 * 24** color video sequence thus occupies **23.6** megabytes for *each* second of viewing.
- **A** 1-hour digital film at the same resolution levels would thus require ***85*** *gigabytes* of storage.

$512*512*3*30B=23592960B\approx23.6*10^6B$

$2^{10}\approx1000\approx1K$

Digital Video

- In recent years, hardware technologies and standards activities have matured enough
  - to transmit, store, process, and view digital video signals
  - to share video signals between different platforms and application areas.

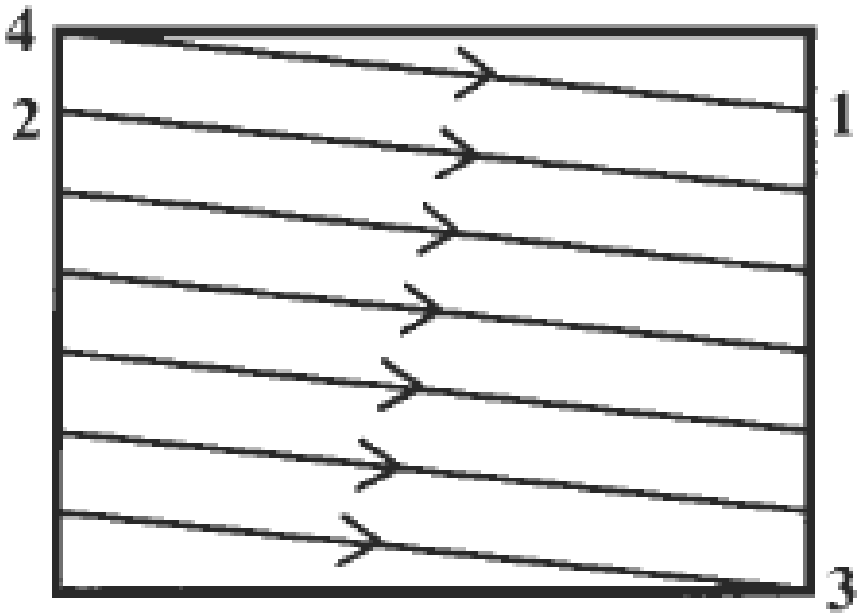
Digital Video– applications:

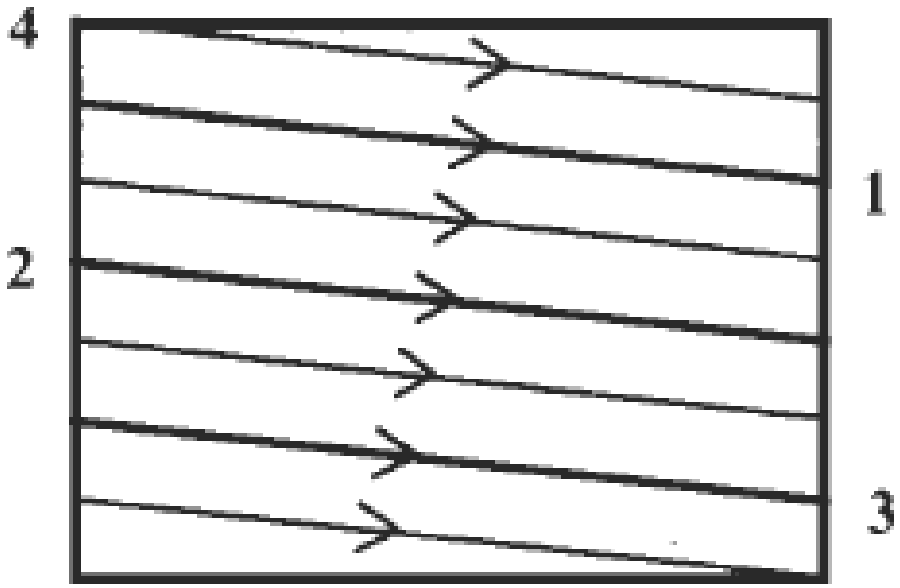
- video teleconferencing
- video telephony
- digital TV, including high-definition television
- internet video
- Medical video
- dynamic scientific visualization
- multimedia video
- video instruction
- digital cinema

Sampled Video

- Video quantization is essentially the same as image quantization. However, video sampling involves taking samples along a new and different (time) dimension.
- The human eye asks the refresh rate more than 50 frames/s

- Analog video systems, such **as** television and monitors, represent video as a one-dimensional electrical signal
  - **Progressive scanning(逐行扫描)**: line by line from top to bottom. For High-resolution computer monitors , the scan rate is 1/72 s/frame, and the refresh rate 72





- Digital video is obtained either by sampling an analog video signal V(***t***)**,** or by directly sampling the 3D space-time intensity distribution that is incident on a sensor.
  - 2D spatial intensity array
  - 3D space-time array.

Video Transmission

- The data volume of digital video is usually described in terms of bandwidth or bit rate (Kilo-/Mega-/Giga- bits/s, bps). 100Mbps, Cable:1Gbps
- Digital video can be compressed very effectively because of the redundancy inherent in the data, and because of an increased understanding of what components in the video stream are actually visible.

Thanks