Graphics

Graphics are usually constructed by the composition of primitive objects such as lines, polygons, circles, curves and arcs. Graphics are usually generated by a graphics editor program (***e.g.*** Freehand) or automatically by a program. Graphics are usually editable or revisable (unlike Images). Graphics input devices include: keyboard (for text and cursor control), mouse, trackball or graphics tablet.

Images

Images are still pictures which (uncompressed) are represented as a bitmap (a grid of pixels). Images may be generated by programs similar to graphics or animation programs. But images may be scanned for photographs or pictures using a digital scanner or from a digital camera. Some Video cameras allow for still image capture also. Analog sources will require digitizing. Images may be stored at 1 bit per pixel (Black and White), 8 Bits per pixel (Grey Scale, Colour Map) or 24 Bits per pixel

Audio

Audio signals are continuous analog signals. They are first captured by a microphones and then digitized and store usually compressed as CD quality audio requires 16-bit sampling at 44.1 KHz.

Video

Analog Video is usually captured by a video camera and then digitized. There are a variety of video (analog and digital) formats. Raw video can be regarded as being a series of single images. There are typically 25, 30 or 50 frames per second. Therefore, a 512x512 size monochrome video images take 25*0.25 = 6.25Mb for a minute to store uncompressed. Digital video clearly needs to be compressed.

Digitization of Multimedia Data

In multimedia, we encounter values of several kinds that change continuously, either because they originated in physical phenomena or because they exist in some analogue representation.

For example,

- The amplitude of (volume) of a sound wave varies continuously over time, as does the amplitude of an electrical signal produced by a microphone in response to time wave.
- The color of the image formatted inside a camera by its lens varies continuously across the image plane.
- When we have a continuously varying signal, both the value we measure and the intervals at which we can measure it, can vary infinitesimally.
- In contrast, if we were to convert it to a digital signal, we would have to restrict both of these to a set of discrete values that could be represented in some fixed number of bits.

Therefore,

- **Digitization**: Digitization is the process of converting analog signals or information of any form into a digital format that can be understood by computer systems or electronic devices. The term is used when converting information, like text, images or voices and sounds, into binary code. Digitized information is easier to store, access and transmit, and digitization is used by a number of consumer electronic devices.is the process of converting a signal from analogue to digital form. **it consists of two steps**:

    - **Discretization (Sampling)**

    The reading of an analog signal *A*, and, at regular time intervals (frequency), sampling the value of the signal at the point. Each such reading is called a *sample* and may be considered to have infinite precision at this stage;

    - **Quantization**

    Samples are rounded to a fixed set of numbers (such as integers), a process known as quantization.

Sampling and quantization can be carried out in either order. **Sampling rate** is the number of samples in a fixed amount of time or space. **Quantization level** is the equally spaced levels to which a signal is quantized.

Digital to Analog Conversion (D/A)?

Digital to analog conversion (D/A) is a process of changing a digital signal (in the form of zeros and ones or highs or lows) to an analog form signal (one with infinitely many levels and states). An electronic device used for his purpose is known as a digital to analog converter or DAC. DAC converts a signal from digital to analog form. Moreover, the DAC are usually available in the form of Integrated Circuits (ICs).

Digital versus Analogue Representation

1. Noise Resistance:

One of the great advantages that the digital representations have over analogue ones stems from the fact that only certain signal values those at the quantization levels- are valid. If a signal is transmitted over a wire or stored on some physical medium, inevitably some random noise is introduced, either because of **interference from stray magnetic fields**, or simply because of the **unavoidable fluctuations** in thermal energy of the transmission medium. This noise will cause the signal value to be changed.

- If the signal is an analogue one, these changes will not be detectable.
- If the signal is a digital one, any minor functions caused by noise will usually transform a legal value into an illegal one that lies between quantization levels.
- Digital signals are therefore much more robust than analogue ones, and do not suffer degradation when they are copied, or transmitted over noisy media.

2. Accuracy

Some information must have been lost during the digitization process. The only meaningful measure of accuracy must be how closely the original can be reconstructed. In order to reconstruct an analogue.

If the original samples were too far apart, any reconstruction is going to be inadequate, because there may be details in the analogue signal that, as it were, slipped between samples.

It is easily to see that if the sampling rate is too low some detail will be lost in the sampling.

Image Formats

This section introduces some of the most common graphics and image file formats. Some of them are restricted to particular hardware/operating system platforms, others are *cross-platform* independent formats. While not all formats are cross-platform, there are conversion applications that will recognize and translate formats from other systems.

Most image formats incorporate some variation of a ***compression*** **technique** due to the large storage size of image files. Compression techniques can be classified into either **lossless** or **lossy**. We will study various video and audio compression techniques.

- **Lossy compression**: refers to compression in which some of the data from the original file (JPEG) is lost. The process is irreversible, once you convert to lossy, you can't go back. And the more you compress it, the more degradation occurs. JPEGs and GIFs are both lossy image formats.
- **Lossless compression** is a class of data compression algorithms that allows the original data to be perfectly reconstructed from the compressed data. By contrast, lossy compression permits reconstruction only of an approximation of the original data.

Dithering: is an intentionally applied form of noise used to randomize quantization error, preventing large-scale patterns such as color banding in images. Dither is routinely used in processing of both digital audio and video data, and is often one of the last stages of mastering audio to a CD. A common use of dither is converting a greyscale image to black and white, such that the density of black dots in the new image approximates the average grey level in the original.

The main strategy is to replace a pixel value (from 0 to 255) by a larger pattern (e.g. 4 _ 4) such that the number of printed dots approximates the greyscale level of the original image

If a pixel is replaced by a 4 _ 4 array of dots, the intensities it can approximate from 0 (no dots) to 16 (full dots). Given a 4 _ 4 dither matrix e.g.

$$\begin{pmatrix} 0 & 8 & 2 & 10 \\ 12 & 4 & 14 & 6 \\ 3 & 11 & 1 & 9 \\ 15 & 7 & 13 & 5 \end{pmatrix}$$

we can re-map pixel values from 0{255 to a new range 0{16 by dividing the value by (256/17) (and rounding down).

A simple dithering approach:

Replace each pixel by a 4 _ 4 dots (binary pixels). If the remapped intensity is > the dither matrix entry, put a dot at the position (set to 1) otherwise set to 0. Note that the size of the dithered image may be much larger. Since each pixel is replaced by 4 _ 4 array of dots, the image becomes 16 times as large.

To keep the image size: an ordered dither produces an output pixel with value 1 i_ the remapped intensity level just at the pixel position is greater than the corresponding matrix entry.

Graphic/Image Data Structures

A digital image consists of many picture elements, termed **pixels**. The number of pixels that compose a monitor image determine the quality of the image (**resolution**). Higher resolution always yields better quality.

A ***bit-map*** representation stores the graphic/image data in the same manner that the computer monitor contents are stored in video memory.

Monochrome/Bit-Map Images

An example 1 bit monochrome image is illustrated in Fig. 6.11 where:

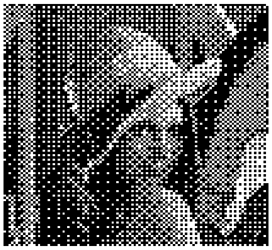

Fig. 6.11

Sample Monochrome Bit-Map Image

- Each pixel is stored as a single bit (0 or 1)
- A 640 x 480 monochrome image requires 37.5 KB of storage.
- ***Dithering*** is often used for displaying monochrome images

Gray-scale Images

An example gray-scale image is illustrated in Fig. 6.12 where:

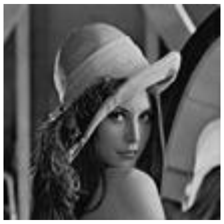

Fig. 6.12