Chapter 1: Information representation and multimedia

Decimal and binary prefix

- Decimal prefix:
  - kilo(K) = 10^3
  - mega(M) = 10^6
  - giga(G) = 10^9
  - tera(T) = 10^{12}
- Binary prefix:
  - kibi(Ki) = 2^{10}
  - mebi(Mi) = 2^{20}
  - gibi(Gi) = 2^{30}
  - teib(Ti) = 2^{40}

Internal coding of numbers

- Coding for integers
- Two methods:
  - Sign-magnitude: 0 is used to represent + and 1 for -
  - Twos complement
- Advantage of twos complement:
  - Only one representation of zero.
  - It simplifies subtraction. Number being subtracted is converted to two's complement form and added to other number.
  - Two's complement values are self-complementary. i.e. Twos complement can be taken to change the sign of number.
  - You can add any number of leading ones to positive and any leading zeros to negative value without changing value.
- Binary coded decimal.
  - Useful when single digit is to be stored or transmitted.
  - The digit is converted to binary and stored.
  - If two BCD digits per byte, it is called packed BCD.
  - If one BCD digit per byte, it is called unpacked BCD.

Internal coding of text

- ASCII code:
  - 7-bits => 2^7 = 128 combinations.
  - Limited number of non-printing or conttrol characters.
  - Only english.

    - Numbers and letters are in sequence.

- Unicode(eg. UTF-8):

    - 1st byte used for ASCII: when first bit is 0
    - Can be upto 4 bytes long but some bytes are used by pre-defined format.
    - Various languages
    - Support for emojis
    - More symbols

Representing images

- Types:
    - Vector image:
        - Consists of drawing list that has command for drawing object to be included in the image.
        - Each command has a list of attributes like shape, color, thickness of line etc.
        - `Can be scaled up` as dimensions are defined relatively.
    - Bitmaps:
        - Image is represented as 2d matrix of pixels.
        - Pixel is the smallest identifiable component of bitmap image. Each pixel has a position and color.
        - `Color depth` is number of bits used to represent a pixel.
        - `Bit depth` is the number of bits used to store each of red, green and blue primary colors in RGB color scheme.
        - `Image resolution` is number of pixels in a image.
        - Bitmap image cannot be scaled up. If that is done, individual pixels can be distinguished.

> Not every image can be defined as a collection of shapes/features so, vector graphics is not practical in every case.

> Vector graphics is often used for logos and bitmap for other daily task.

Representing sound

> Sound we hear is continuous and irregular and representing it requires practically infinite data. So, sampling is done.

- `Sampling` is the process of taking value from analogue signal at regular interval to make it digital.
- Sampling is done by ADC: Analog to digital converter.
- Sample refers to one such value taken from analogue signal.
- `Sampling resolution` is the number of bits used to represent a sample.
- `Sampling rate` is the number of samples taken per second.

> Nyquist's theorem => Sampling must be done with a frequency at least twice the highest frequency of the sound being sampled.

> Videos are collection of images + sound.

Compression techniques.

> Compression refers to reduction in file size.

- Reasons:
    - Less storage requirement.
    - Lower download/transmission time.
    - Lower processing time.
- Types:
    - Lossless compression: no information is lost
    - Lossy compression: some information is lost
- Examples:
    - Lossy compression:
        - Image: Cropping, reducing color depth, etc.
        - Video: reducing resolution, reducing frame rate etc.
        - Audio: reducing sampling rate, reducing sampling resolution etc.
    - Lossless compression:
        - Run Length Encoding(RLE): Number of times a byte is represented and the byte are sent together.
        - Huffman encoding: Using less bits to represent most frequently used values. None of the codes begin with sequence of bits representing shorter codes. A table is also required.

> Mostly RLE is used for bitmap images, Huffman encoding for audio.

> Lossy compressions cannot be used for texts.

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