دانشکده آموزش های الکترونیکی دانشگاه شیراز

سیستم های چند رسانه ای

فشرده سازی داده ها

وحید اعتمادی

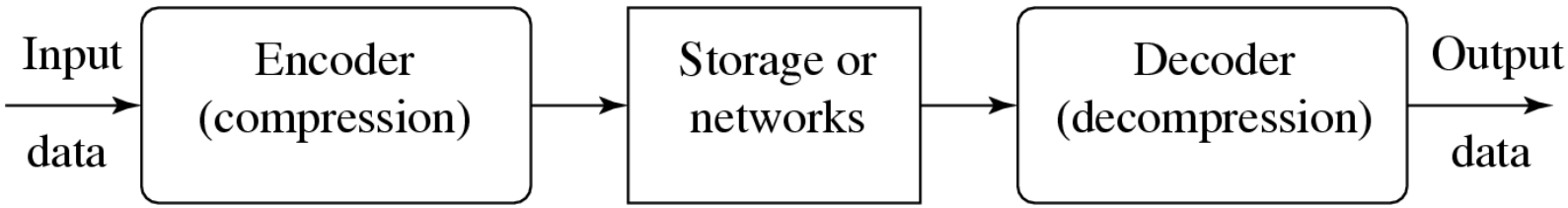
بهار 94

Outline

- Introduction
- Motivation for compression
- Coding requirements
- Compression types

Introduction

- **فشرده‌سازي (Compression)**: به فرايند رمزكردن كه منجر به كاهش موثر تعداد كل بيت‌هاي لازم براي ارائه اطلاعات مشخصي مي‌شود، فشرده‌سازي گفته مي‌شود.



شماي كلي از فشرده‌سازي

ضريب فشرده سازی

- **ضريب فشرده‌سازي:**

$$\text{ضريب فشرده سازي} = \frac{B_0}{B_1}$$

B0 - تعداد بيت‌ها قبل از فشرده‌سازي

B1 – تعداد بيت‌ها بعد از فشرده‌سازي

مثال

- اگر تعداد بیت‌ها پس از فشرده‌سازي نصف شود میزان نرخ فشرده‌سازي چقدر خواهد بود؟
  - 0.5
  - 2
  - 1/5
  - 0.66

Motivation for Compression

- Terminology
  - 1 kbit = 1000 bit(e.g. network bandwidth)
  - 1 Kbit = 1024 bit (= 2^{10})(e.g. memory size)
  - 1 Mbit = 1024 x 1024 bit (= $2^{10} * 2^{10} = 2^{20}$)
- Discrete Data: Considering a small window of 640 x 480 pixels on a display
  - Text
  - Vector Image
  - Bitmap Image
- Continuous Data: Required storage space per second
  - Uncompressed speech of telephone quality
  - Uncompressed stereo audio signal of CD quality
  - Video sequence

Motivation for Compression: Discrete Data

- Text
  - Assuming 2 bytes are used for every 8 x 8 pixel character,
    - Character per screen page = ...
    - Storage required per screen page = ...
- Vector Image
  - Assuming that a typical image consists of 500 lines, each of which is defined by its coordinates in the x direction and the y direction, and an 8-bit attribute field
    - Coordinates in the x direction require ...
    - Coordinates in the y direction require ...
    - Bits per line = ...
    - Storage required per screen page
- Bitmap Image
  - Assuming using 256 colors requiring a single byte per pixel
    - Storage required per screen page = ...

Motivation for Compression: Continuous Data

- Uncompressed speech of telephone quality
  - Assuming being sampled at 8 kHz and quantized using 8 bit per sample yielding a data stream of 64 Kbit/second
    - Storage space required per second = ...
- Uncompressed stereo audio signal of CD quality
  - Assuming being sampled at 44.1 kHz and quantized using 16 bits
    - Data rate = ...
    - Storage space required per second = ...

Motivation for Compression: Continuous Data

- Video sequence
  - Assuming 25 full frames per second, luminance and chrominance of each pixel are coded using 3 bytes, luminance sampled at 13.5 MHz while chrominance (R-Y and B-Y) is sampled at 6.75 MHz, each, and samples are uniformly coded using 8 bits.
    - Bandwidth = ...
    - Data Rate = ...
    - Storage space required per second = ...

Motivation for Compression: Continuous Data

- Processing uncompressed video data streams requires
  - Storage space in the gigabyte
  - Buffer space in the megabyte
  - Data transfer rates of 140 Mbit/s [per unidirectional connection]
- These requirements can be considerably lowered by employing compression

Can Multimedia Data be Significantly Compressed?

- Redundancy can be exploited to do compression
- Spatial(مکانی) redundancy
  - correlation between neighboring pixels in image/video
- Spectral(طیفی) redundancy
  - correlation among colors
- Psycho-visual redundancy
  - Perceptual properties of human visual system

What Makes “Good” Compression

- Quality of compressed and decompressed data should be as good as possible
- Compression/decompression process should be as simple as possible
- Decompression time must not exceed certain thresholds
- [De]/Compression requirements can be divided into
  - Dialogue mode (video conferencing)
  - Retrieval mode (digital libraries)
  - Both

Coding Requirements: Dialogue Mode

- End-to-end delay does not exceed 150 ms for compression and decompression alone.
  - Ideally, compression and decompression should not exceed 50ms in order to ensure natural dialogue.
    - In addition
      - delay in the network,
      - communications protocol processing in the end system

Coding Requirements: Retrieval Mode

- Fast forward and fast rewind(a mechanism for rewinding a tape or film) with simultaneous display (or playback) of the data should be possible
- Random access to single images or audio passages in a data stream should be possible in less than 0.5 s.
  - Maintains interaction aspects in retrieval systems
- Decompression of images, video or audio passages should be possible without interpreting all preceding data.
  - Allows random access and editing

Coding Requirements: Both Modes

- Support display of the same data in different systems
  - Formats have to be independent of frame size and video frame rate
- Audio and video compression should support different data rates at different qualities
- Precisely synchronize audio and video
- Support for economical solution
  - Software
- Enable cooperation of different systems
  - Data generated on a multimedia system can be reproduced on another system (e.g. course materials).

Compression Types

- Physical versus logical Compression
  - Physical
    - Performed on data regardless of what information it contains
    - Translates a series of bits to another series of bits
  - Logical
    - Knowledge-based
      - e.g. United Kingdom to UK
- Spatial Compression – 2D or single image
- Temporal Compression – 3D or video
- Codec – Compression / Decompression

Compression Types

- Symmetric
  - Compression and decompression roughly use the same techniques(استفاده از یک تکنیک واحد) and take just as long
  - Data transmission which requires compression and decompression on-the-fly will require these types of algorithms
- Asymmetric
  - Most common is where compression takes a lot more time than decompression
    - In an image database, each image will be compressed once and decompressed many times
  - Less common is where decompression takes a lot more time than compression
    - Creating many backup files which will hardly ever be read

Compression Types

- Non-adaptive
  - Contain a static dictionary of predefined substrings to encode which are known to occur with high frequency
- Adaptive
  - Dictionary is built from scratch

Compression Types

- Lossless
  - decompress(compress(data)) = data
  - Used for computer data, medical images, etc.
- Lossy
  - decompress(compress(data)) $\neq$ data
  - Some distortion
  - A small change in pixel values may be invisible
  - Suited for audio and video