AY 2019/2020
EE6403 Distributed Multimedia Systems

Part 1 Media and Systems

Dr Yap Kim Hui

Room: S2-B2b-53
Tel: 6790 4339
Email: ekhyap@ntu.edu.sg

Course Outline

- Media and Systems
- Media Compression and Standards
- Media Processing and Storage
- Media Transmission and Delivery
- Quality of Service on Distributed Multimedia Systems
- Multimedia Applications

References

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Assessment

- Examination: 80%
  - 5 Questions
  - Closed-book

- Continuous Assessments (CAs): 20%
  - CA 1: Assignment (10%)
  - CA 2: Quiz (10%)

Section I
Media and Systems

Media and Systems

- Introduction
- Media applications
- Media types and characteristics
- Color models/spaces
- Media compression basics
- Image & video standards

Introduction

What is Multimedia?

- Multimedia: multi + media
  - Multi: numerous (Latin word multus)
  - Media: intermediary (plural form of medium)
  - Multimedia: numerous ways/intermediaries of conveying information including visual, audio, smell, touch, etc.
- Different media environments
  - Social media: Facebook, Twitter, Instagram
  - Mass media: newspaper, magazine, radio, TV
  - Platform: mobile phones, PCs, TVs, radios, paper media

Digital Multimedia

- Multimedia is an interdisciplinary, application-oriented technology that capitalizes on multi-sensory nature of humans and the ability of computers to store, manipulate and convey information such as video, graphics and audio in addition to textual information.

- Digital multimedia is the field concerned with the integration of text, graphics, images, audio, speech, video, animation, and any other medium where every type of information can be presented, stored, transmitted and processed digitally.

Multimedia Attributes

- Digitized:

  Media are represented in digital format.
- Computerized:

  Media are processed/controlled by computers.
- Distributed:

  Information is relayed from remote terminals (stored in advanced or produced in real-time).
- Interactive:

  Media can be searched, browsed, filtered, indexed, and presented according to user needs.
- Integrated:

  Media are integrated for presentation.

Multimedia Aspects (I)

- Representation

  Digitization: sampling, quantization and coding (compression)
- Storage

  Large storage requirement and new access patterns
- Processing

  Operating systems, indexing, searching, filtering
- Understanding

  Content analysis, speech recognition, object recognition, etc.
- Production

  Multimedia authoring

Multimedia Aspects (II)

- Presentation

  User consumption/perception and ease of interaction

- Protection

  Security, copyright protection, data encryption

- Distribution

  Media delivery and broadcasting

- Communication

  Media transmission over network

Media Applications

Multimedia Applications

- Business
  - E-business, m-business, online shopping, etc.
- Entertainment
  - Video streaming, virtual reality gaming, etc.
- Education
  - Technology enabled learning, massive open online course (MOOC), etc.
- Science and technology
  - Augmented reality, autonomous vehicles, etc.

Augmented Reality Glasses

Virtual Reality Gaming

Multimedia Trends (I)

- Convergence of computers, telecommunications, networking infrastructure, and portable devices.
- Better infrastructure and technologies provides higher bandwidth and better quality.
- Faster processors, larger-capacity storage devices.
- New human-computer interface.

Multimedia Trends (II)

- Pervasive computing: “anywhere, anytime”.
- New algorithms, standards and learning techniques: e.g. AI, deep learning.
- Big data
- Sensors on devices: Internet-of-Things (IoTs)

Future Trends

Hyper-Reality

Technical Issues in Media Processing

- Compression
  - algorithms and standards
- Communications
  - streaming techniques, quality of service
- Content Analysis and Understanding
  - speech recognition, object recognition, etc.
- Storage and retrieval
  - storing, searching, retrieving, annotating media contents.

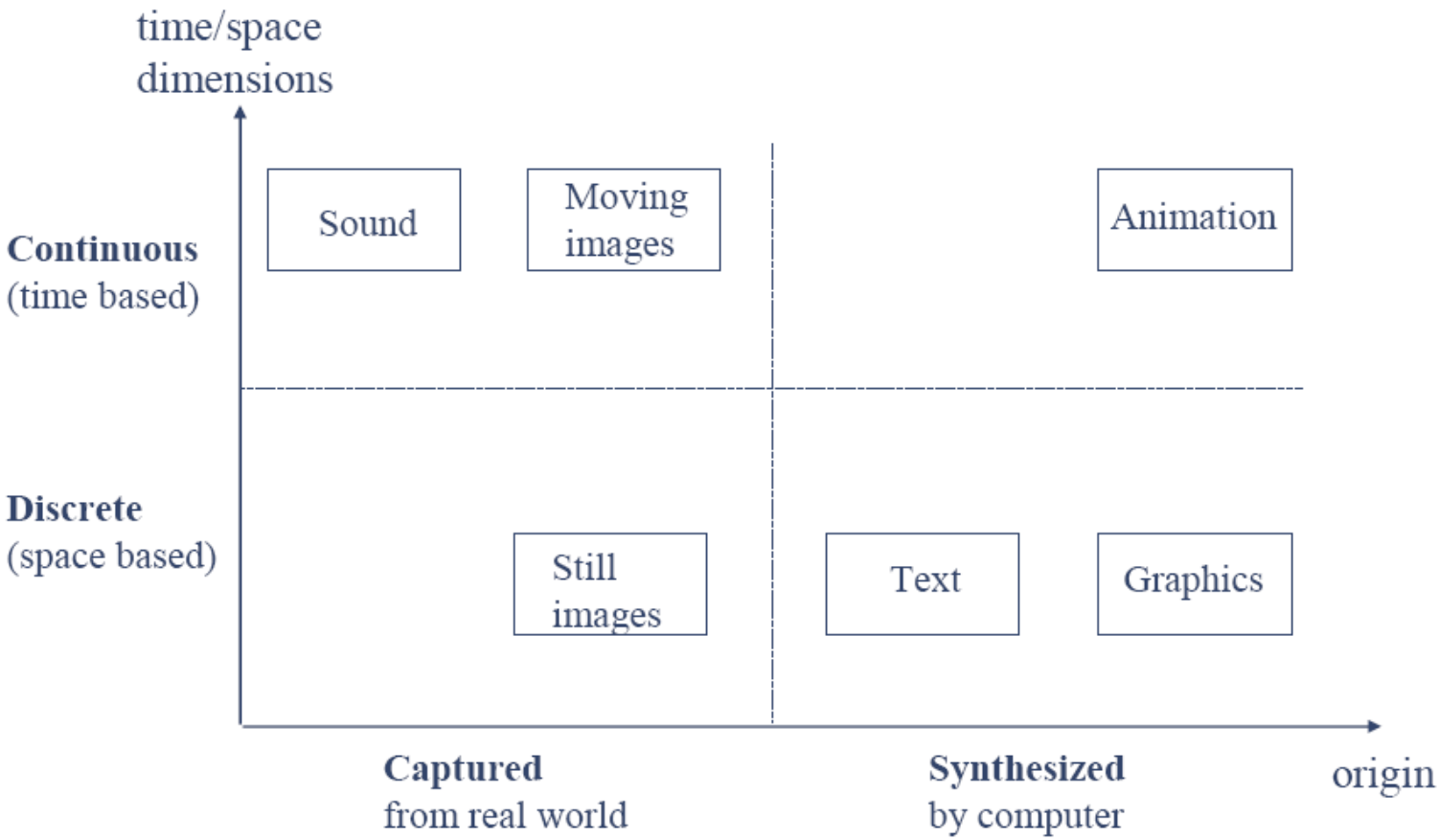
Multimedia Signal Processing

Media and Characteristics

Media Types

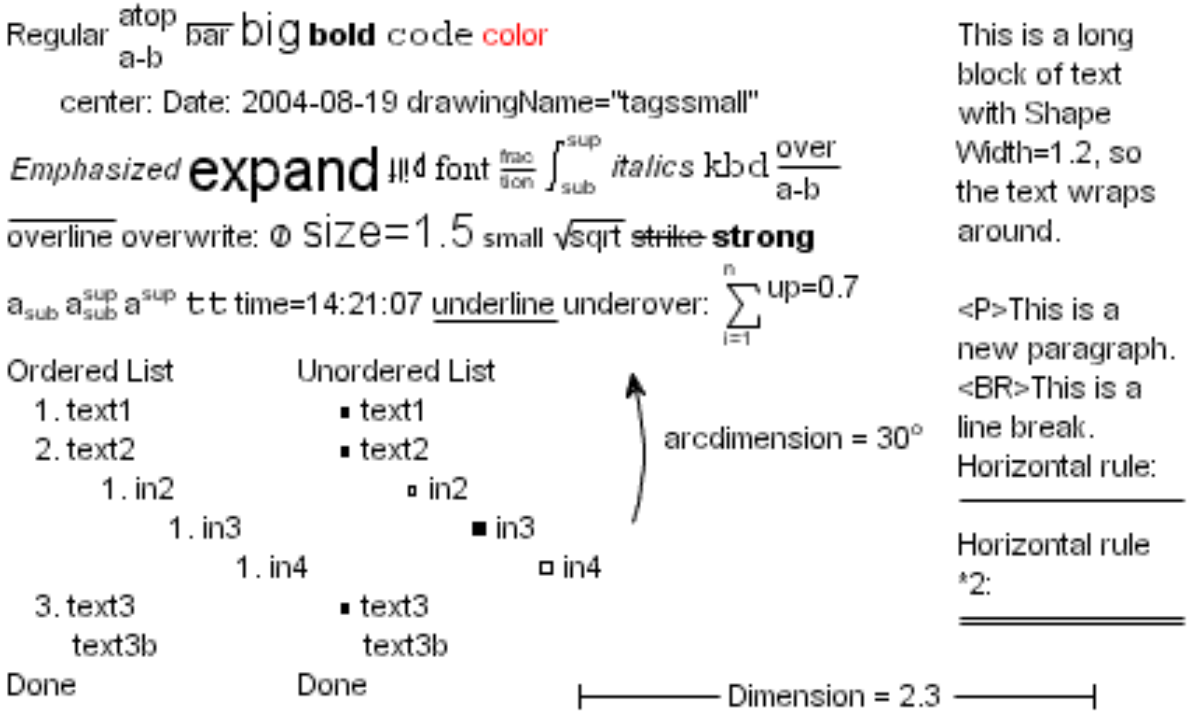
- Text
- Graphic
- Image
- Video
- Animation
- Audio
- Speech

Classification of Media



Text

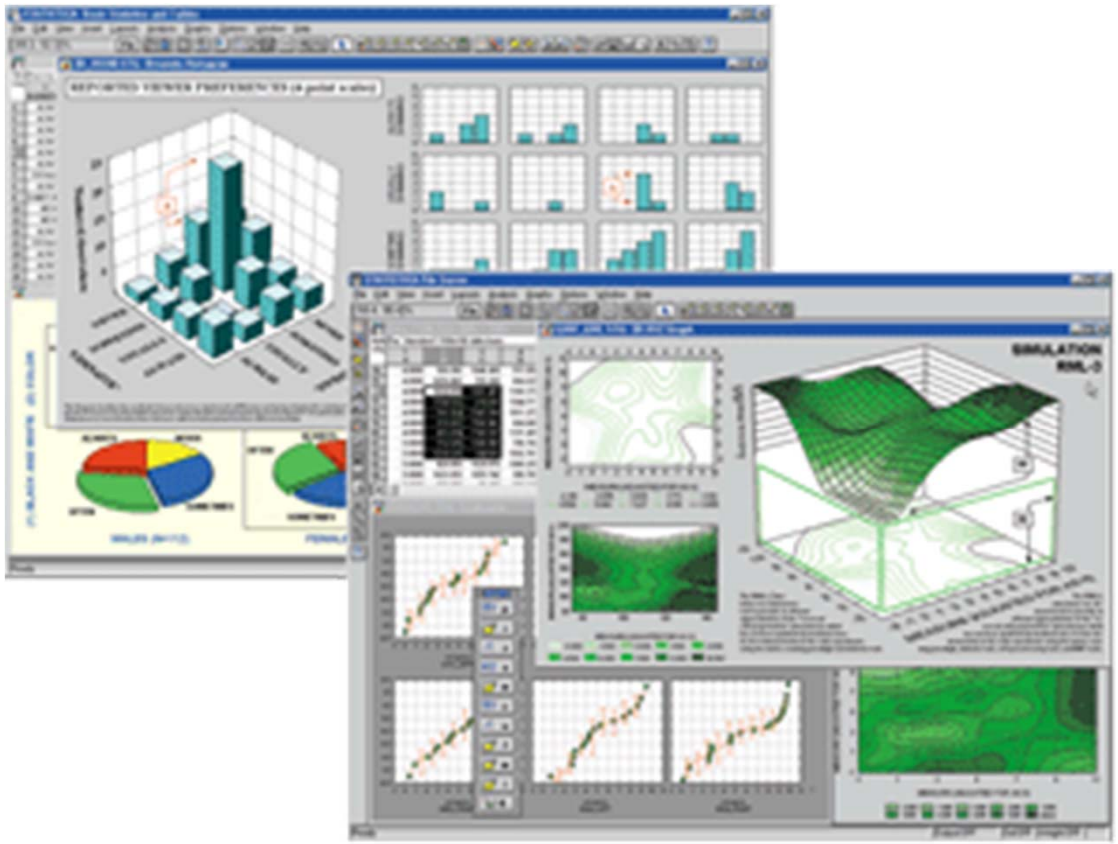
- Letters, numbers, punctuations, special characters and controls created with a text editor or word processor



Source: http://www.cohort.com/tags.gif

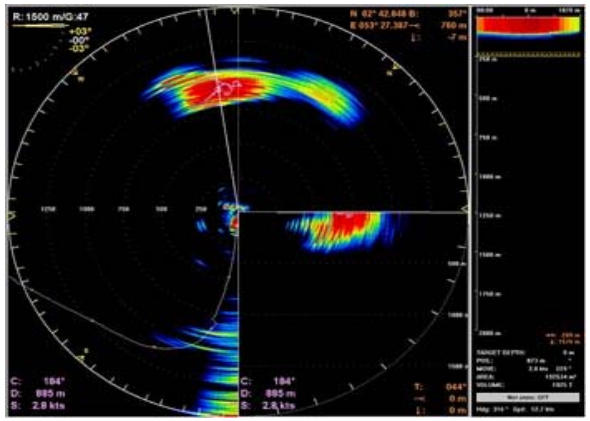
Graphics

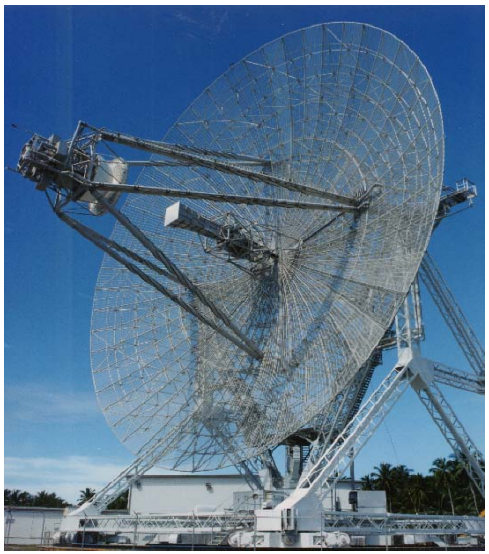
- Lines, circles, boxes, shading, fill colours etc., created with a drawing program.



Images

- Still pictures, expressed as the colours of many small individual picture elements (pixels).





Source:
http://www.c7f.navy.mil/news/2002/2/10.htm
http://www.fadio.ird.fr/sonars.htm
http://www.smdc.army.mil/SMDCPhoto_Gallery/Sensors/Radar.jpg

Animation

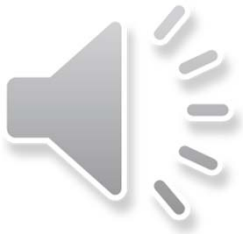
- A simulation of movement created by displaying a series of pictures, or frames. Cartoons on television is one example of animation.

Video

- Successive pictures presented sufficiently rapidly to give the perception of smooth motion.

Audio

- Sound, including voice, music and special effects, either captured from nature or synthesized.



Color Models/Spaces

Color Spaces

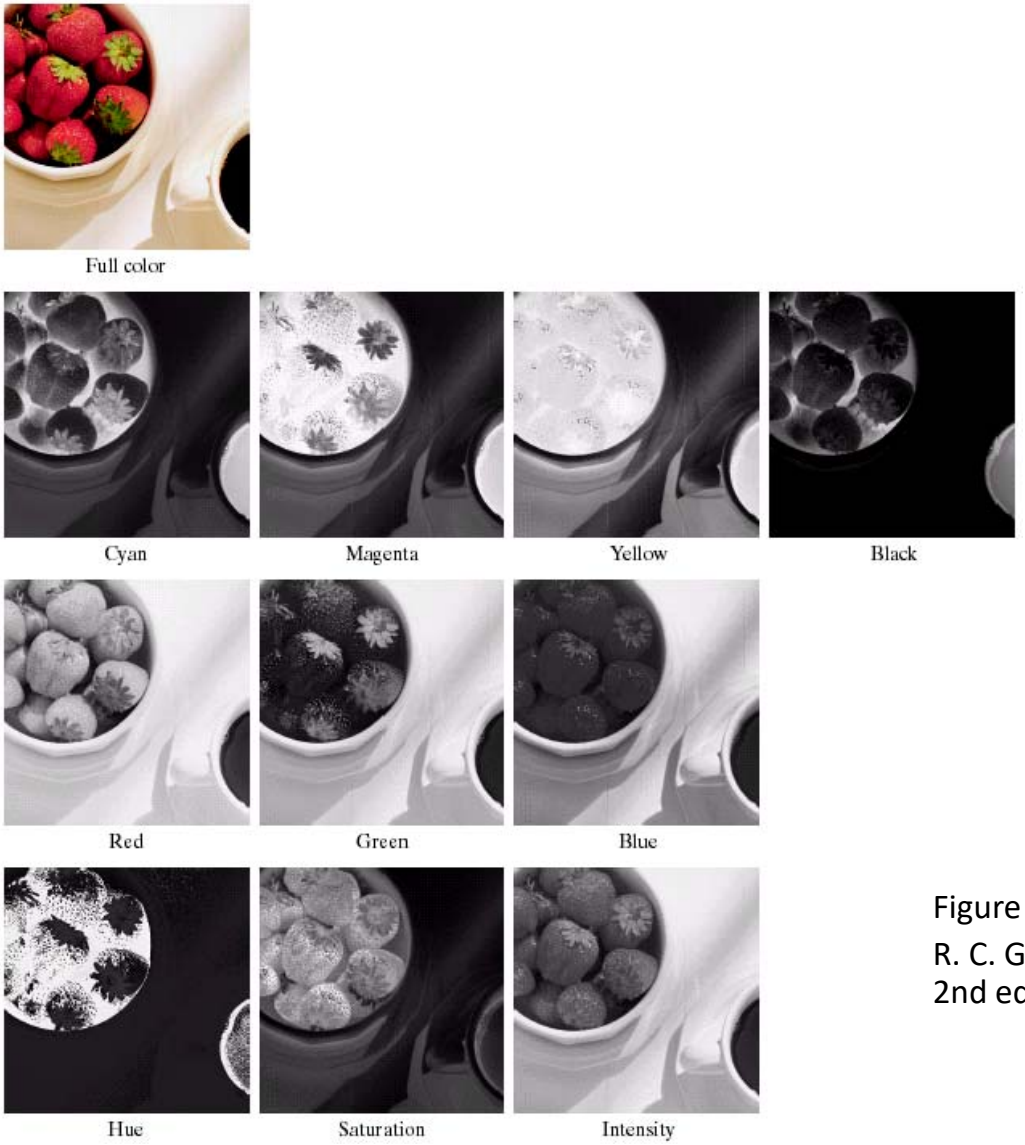


Figure source:

R. C. Gonzalez and R. E. Woods, Digital Image Processing, 2nd edition, Prentice Hall, 2002

RGB

- Colours represented by numeric triplet: red (R) , green (G), and blue (B).
- Convenient for video display drivers in colour CRTs.

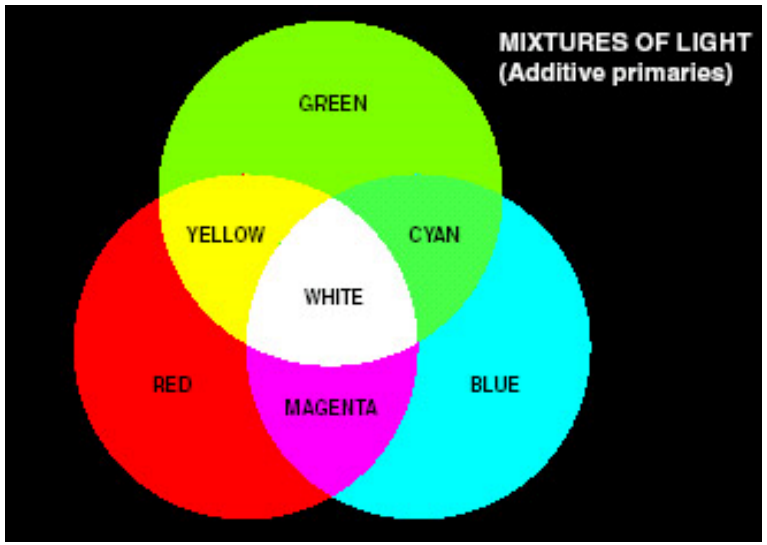


FIGURE 6.7
Schematic of the RGB color cube. Points along the main diagonal have gray values, from black at the origin to white at point (1, 1, 1).

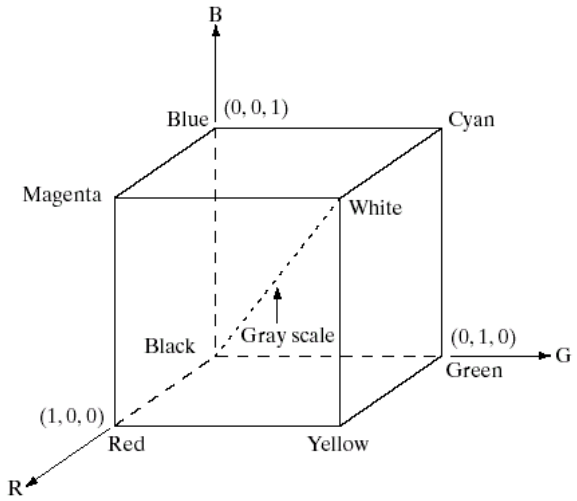


Figure source:
R. C. Gonzalez and R. E. Woods, Digital Image Processing, 2nd edition, Prentice Hall, 2002

HSI

- Colours represented by a triplet: hue (H), saturation (S), and intensity (I)
- Hue: measure purity of a colour
- Saturation: measure to which a pure colour is diluted by white colour
- Intensity: amount of gray level (brightness) in the colour

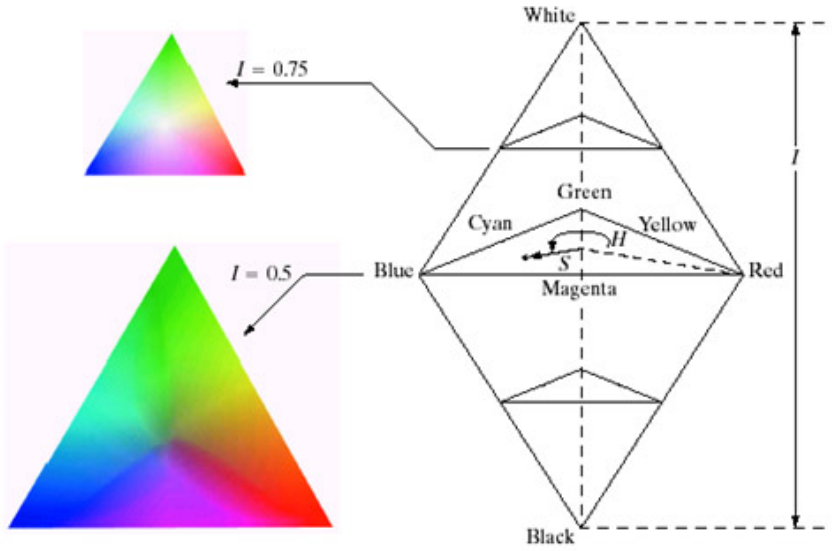


Figure source:
R. C. Gonzalez and R. E. Woods, Digital Image Processing, 2nd edition, Prentice Hall, 2002

CMY

- Colours represented by: cyan (C), magenta (M), and yellow (Y)
- Used in printers

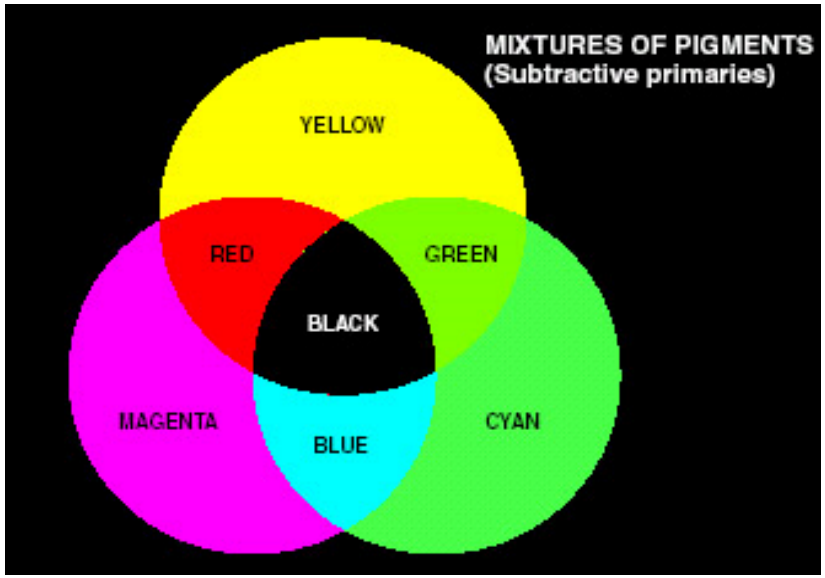


Figure source:
R. C. Gonzalez and R. E. Woods, Digital Image Processing, 2nd edition, Prentice Hall, 2002

YUV, YIQ, YC_BC_R

- Variation of YUV-like models: YIQ and YC_bC_r.
- Y (luminance) is the brightness (black-and-white part) of video signal, UV (chrominance) is the colour part of video.
- YUV is suitable for video broadcast since it makes efficient use of bandwidth.
- Used in TV industry:
  - YUV (PAL, SECAM), YIQ (NTSC), YC_bC_r (JPEG, MPEG)

RGB -> YIQ

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

YIQ -> RGB

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1.0 & 0.956 & 0.620 \\ 1.0 & -0.272 & -0.647 \\ 1.0 & -1.108 & 1.700 \end{bmatrix} \begin{bmatrix} Y \\ I \\ Q \end{bmatrix}$$

Media Compression Basics

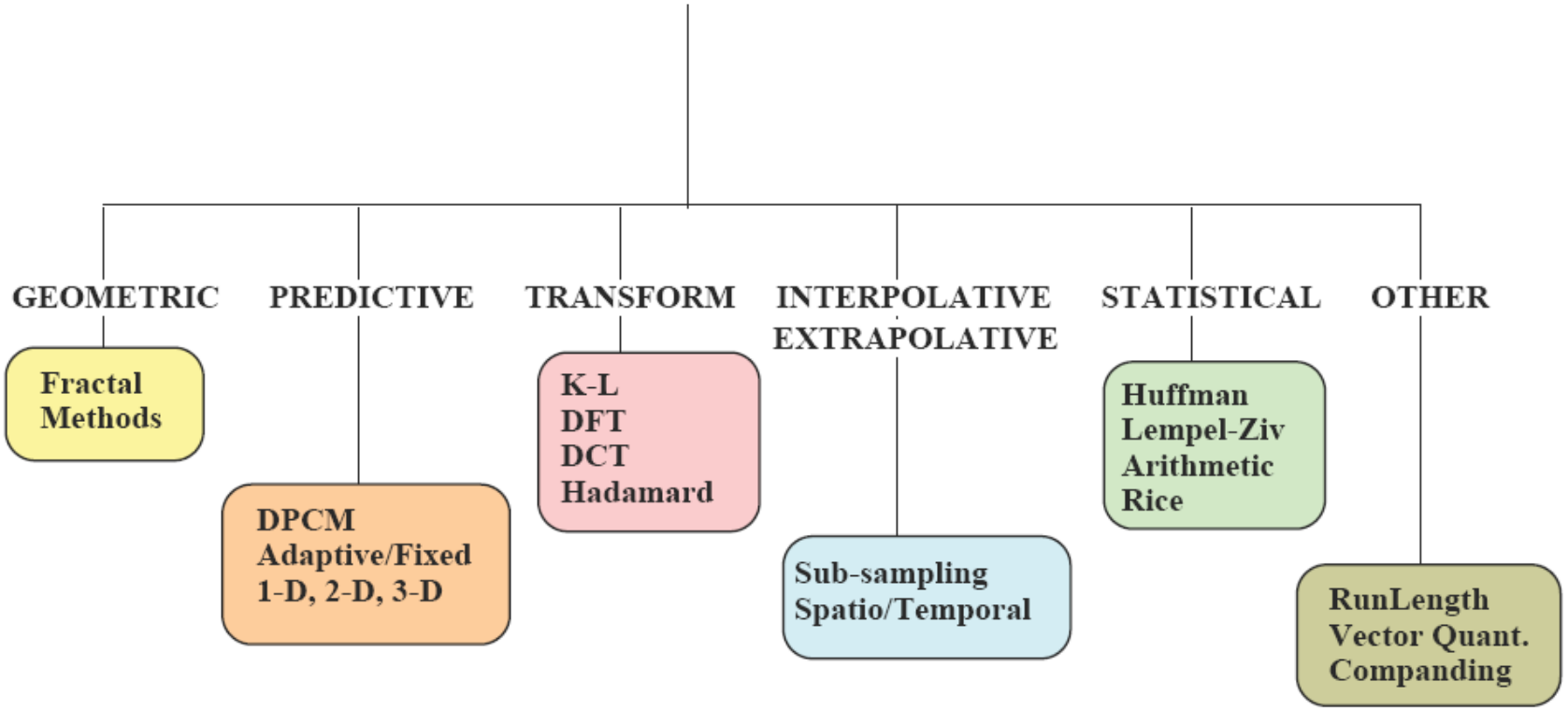
Motivation for Media Compression

- Storage requirements:
  - A page of text ~ 3 KB
  - A 300-page book ~ 900KB
  - An uncompressed image (640x480) ~ 1 MB
  - 1 second of uncompressed video (30fps)~ 27 MB
  - 1 hour of uncompressed video ~ 100 GB

Why Media Compression is Possible?

- Multimedia data has significant data redundancy
  - Spatial Redundancy
  - Temporal Redundancy
  - Psycho-visual Redundancy

Data Compression Techniques



Source: Will Geckle - Johns Hopkins University

Image & Video Standards

Image

- Image is an important media type in information storing, processing, presentation, and interaction.
- Image is represented by a 2D matrix composed of rows and columns of pixels – the smallest image resolution elements
- Some popular image formats:
  - JPEG (Joint Photographic Expert Group)
  - TIFF (Tagged Image File Format)
  - BMP (Bitmap)
  - Etc.

JPEG

- A very popular image compression standard.
- JPEG is known as ISO/IEC international standard 10918 or the ITU-T Recommendation T.81.
- Developed by an international body known as Joint Photographic Expert Group (JPEG).
- Four distinct modes of operation:
  - sequential DCT-based mode
  - progressive DCT-based mode
  - lossless mode
  - hierarchical mode

Digital Video

- Digital video is a sequence of frames, with audio signals.
- MPEG is a popular video compression standard.
- Developed by MPEG (Moving Picture Experts Group)
- ISO/IEC JTC 1 /SC 29 / WG 11
  - International Standards Organization / International Electro-technical Commission
  - Joint Technical Committee Number 1
  - Subcommittee 29, Working Group 11
- Developed a set of coding standards involving video with sound.

MPEG Overview

- MPEG-1 (1992)
  - Video and audio coding (CD-ROM, 1.5Mbps)
  - Relevant product: VCD
- MPEG-2 (1994)
  - Video and audio coding with different profiles (2-80Mbps)
  - Relevant product: DVD
- MPEG-4 (v1:1999, v2: 2000, v3: 2001)
  - Content-based video coding
  - Coding of natural and synthetic media objects
- MPEG-7 (2001)
  - Multimedia content description scheme
  - Media indexing, searching, browsing, filtering

H.261, H.263

- H.261
  - Developed by CCITT in 1990.
  - DCT-based video compression scheme.
  - Many similar features with MPEG-1 video coding.
  - Target application: videoconferencing, video-telephone over ISDN telephone lines.
  - Bit-rate is *p* x 64 Kbps, where *p* ranges from 1 to 30.

- H.263
  - ITU-T Recommendation H.263 v1 in 1995.
  - Superior to H.261, current standard for videoconferencing.
  - H.263 v2 (H.263+, 1998)
  - H.263 v3 (H.263++, 2000)

Image/Video Standards

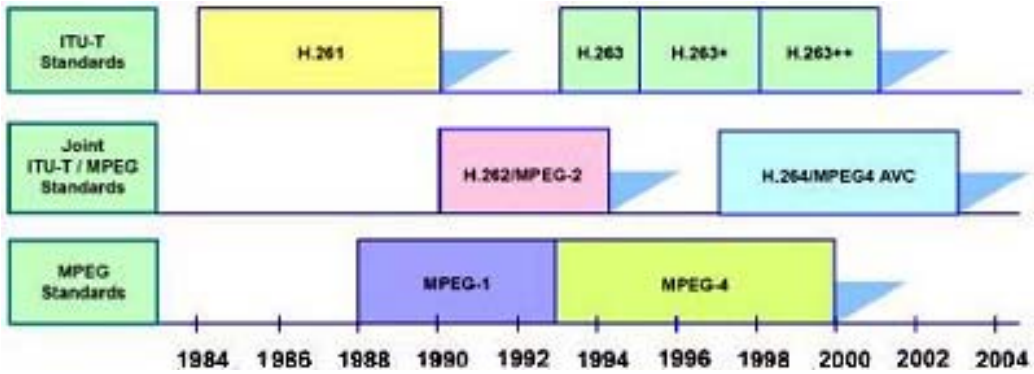


TABLE 15.2
Video/Image Coding Standards

Name	Completion Time	Major Features
JPEG	1992	For still image coding, DCT based
JPEG-2000	2000	For still image coding, DWT based
H.261	1990	For videoconferencing, 64Kbps to 1.92 Mbps
MPEG-1	1991	For CD-ROM, 1.5 Mbps
MPEG-2 (H.262)	1994	For DTV, 2 to 15 Mbps, most extensively used
H.263	1995	For very low bit rate coding, below 64 Kbps
H.263+ (version 2)	1998	Add new optional features to H.263
MPEG-4	1999	For multimedia, content-based coding
MPEG-4 (version 2)	2000	Adds more tools to MPEG-4
H.263++	2000	Adds more optional features to H.263+
H.26L	2000	Functionally different, much more efficient
MPEG-7	2001	Content description and indexing

Summary

- This section covers the followings:
  - Introduction
  - Media applications
  - Media types and characteristics
  - Color models/spaces
  - Media compression basics
  - Image & video standards