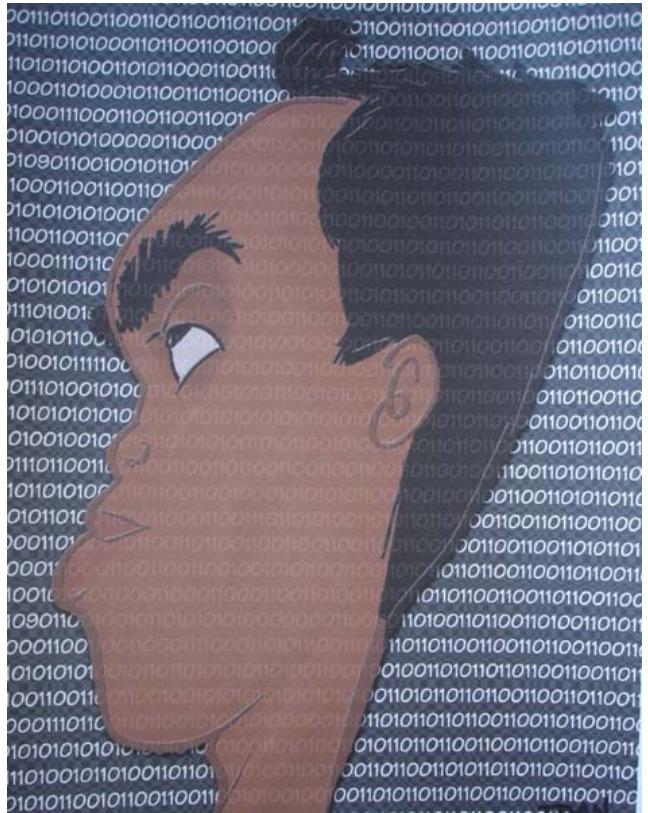


MULTIMEDIA SYSTEMS DESIGN – CS576

DR. PARAG HAVALDAR

havaldar@usc.edu

YOUR INSTRUCTOR!



COURSE WEB PAGE ON DEN

TIMES – Mon 6:40 pm – 10:10 pm

Class Location: SGM 124

Office Location: TBD

Office Hours: before/after class Mondays*

Teaching Assistant/Course Producer:

Weiyue Wang



Marko Sterbentz



Email : weiyuewa@usc.edu

Phone: skype: [wangweiyue12345@hotmail.com](skype:wangweiyue12345@hotmail.com)

Office Hours: Tuesday - 2:00pm – 4:00pm

Wednesday 9:30am – 11:30am

Location : PHE 108

Email : sterbent@usc.edu

Phone: **208-346-1921**

Office Hours: Monday - 11:00am – 1:00pm

Thursday 11:00am – 1:00pm

Location : SAL 100 lobby

COURSE DETAILS

PREREQUISITES

Good Programming Skills

Basic Math Skills

Helpful – Signal Processing, Graphics, Networks...

COURSE GRADE DECISION

One Term Exam - 40% (Mon April 1 2019 *tentative*)

Assignments, Project 50%

- 2 to 4 Theory/Programming Assignments (20%)**
- Project, done in a groups (30%)**

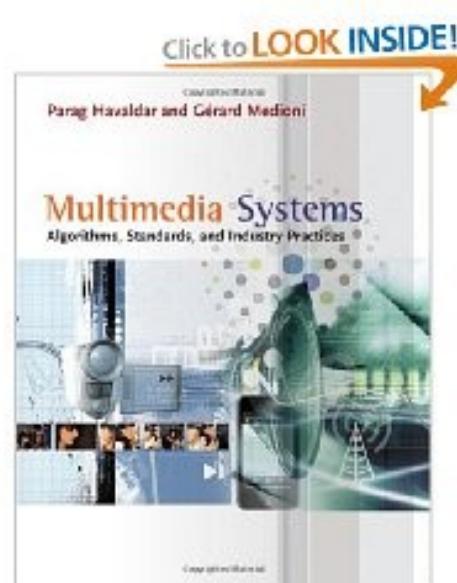
Participation and ICT Lectures - 10%

BOOKS

List of Recommended Books:

- Ze Nian Li , Mark S. Drew, *Fudamentals of Multimedia*, Prentice Hall, 2004
- S.V. Raghavan, S.K. Tripathi, *Networked Multimedia Systems: Concepts, Architecture, and Design*. Prentice Hall, 1998
- F. Kuo, W. Effelsberg, J.J. Garcia-Luna-Aceves, *Multimedia Communications: Protocols and Applications*. Prentice Hall PTR, 1998
- David S Taubman, Micheal W. Marcellin, *JPEG 2000 – Image Compression, Fundamentals, Standards and Practice*, Kluwer Academic Publishers 2002
- Mohammed Ghanbari, *Video Coding – An Introduction to Standard Codecs*. The Institution of Electrical Engineers (IEE), London, UK, 1999.
- A. Puri, T. Chen (eds.), *Multimedia Systems, Standards, and Networks*. Marcel Dekker, 2000
- Ming-Ting Sun, Amy R. Reibman (eds.), *Compressed Video over Networks*. Marcel Dekker, 2000
- Marin Bosi and Riach E. Goldberg, *Introduction to Digital Audio Coding and Standards*, Kluwer Academic Publishers 2003
- Foley, Van Dam, Feiner, Hughes, *Computer Graphics – Principles and Practice*, Second Edition. Addison-Wesley – 1990.

REQUIRED BOOK



Multimedia Systems – Algorithms, Standards and Industry Practices.
-Parag Havaldar and Gerard Medioni

INTRODUCTION



EXAMPLES AND !EXAMPLES

Reading a newspaper YES/NO?

Describing a Picture to your friend YES/NO

Video Game Playing and Multiplayer Game YES

Riding a bicycle NO

Video Conferencing YES

Visiting your doctor NO

Watching Television YES

Assembling a car in a garage NO

Listening to Radio YES/NO

Having a phone conversation YES/NO

INTRODUCTION

Historical Perspective

When was the word multimedia created?

Timeline of information creation and distribution

Multimedia Data and Information

Contains a mixture different types of media – text, images, video, audio, graphics

Definition and media types have been changing

Multimedia Systems

- Generation**
- Processing**
- Storage**
- Distribution**
- Rendering**

HISTORICAL PERSPECTIVE OF MEDIA

Age	Time and Era	Type of Information	Storage medium	Mode of Distribution
Prehistoric	15000BC	Sounds, Gestures Painting	Rocks, cave walls	-
Ancient	500 BC	Alphabets, Drawing	Invention of paper	People delivering messages, Horse back
Middle Ages	400-1000 AD	Letters, Writing	Books	Beginning of a postal system
Renaissance	1300-1800 AD	News, paintings, magazine	Books, Libraries	Printing press, steam engines, automobiles
Modern World	1900 AD	Morse Code, radio, Photographs, Movies	Film, Magnetic Tapes, Phonograph	Telegram service, wireless radio waves
Electronic	1950-1980	Telephone, Television, Fax, Computers	Electronic memory, cassette tapes. LP records	Radio and TV Broadcasting, Satellite Communication
Digital	1980 to present day	Computers, Digital Video, Surround Sound	Hard Disks, CDROMs, DVDs, IPTV, Facebook,	Ethernet, Wireless Networks, Optical networks, Cell phone networks

COMPONENTS OF A MULTIMEDIA SYSTEM

Capture devices –

Video camera, audio microphone, keyboard etc.

S/W Processing Elements –

S/W for content creation, compression, encryption etc.

Storage devices – CDROMS, Hard disks, Memories

Distribution network –

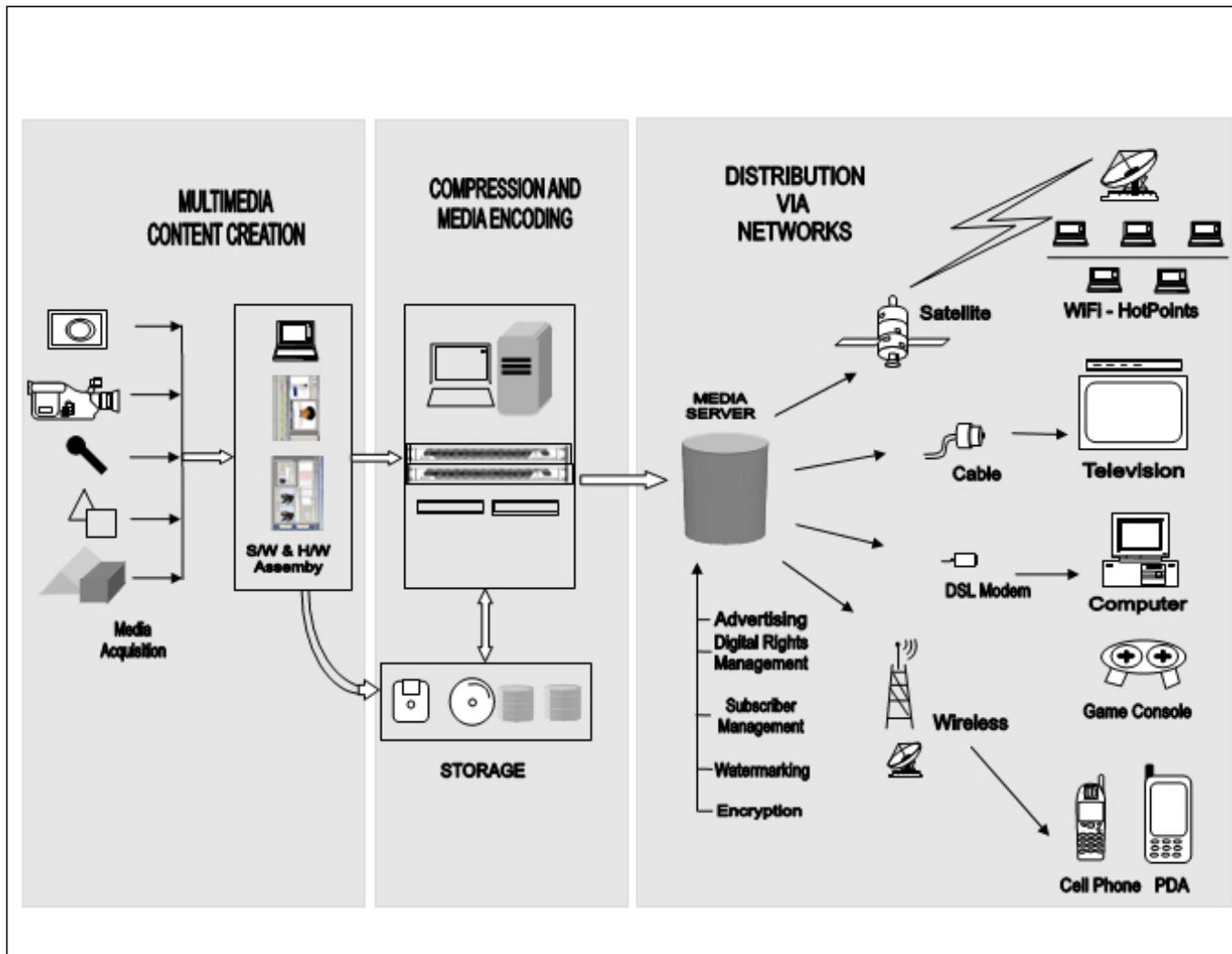
Ethernet (10-100 Mbs), ATM, Fiber Optics, Wireless

Processing devices

CPUs, Set Top boxes, workstations, DSP hardware

Display / Rendering devices -

HiRes Monitors, Speakers, HDTV, Projectors, Printers



MEDIA TYPES – AN “IN”COMPLETE TAXONOMY

Current Media Types

- Text – Hypertext
- Images – Static & Dynamic
- Audio – Speech, Music
- Video – Movies, Documentaries
- 2D Graphics – Vector Graphics, 2D Sprites
- 3D Graphics – Games

Future Media Types

TEXT

This is a line of text to explain that text does convey information!

[Hypertext](#)

IMAGES – GRAY & COLOR



IMAGES – FAX

Medium	QoS Parameter	Range	Quality Characterization
Video		64 Kbps–2 Mbps	H.261 encoded videoconferencing
		1.2 Mbps	MPEG-1 VCR Quality
		2–4 Mbps	MPEG-2 broadcast quality TV
		3–6 Mbps	MPEG-2 compressed studio-quality TV
		140–166 Mbps	Uncompressed TV, PCM coding
		25–34 Mbps	HDTV lossy MPEG-2 compression
		around 500 Mbps	HDTV lossless compression
		≥ 1 Gbps	HDTV uncompressed quality
	Bit-error rate	$\leq 10^{-6}$	Long-term bit-error rate
	Packet loss rate	$\leq 10^{-2}$	Uncompressed video
Bit-error rate		$\leq 10^{-11}$	Compressed video
	End-to-end delay	250 msec	Video telephony
		200 msec	JPEG video transmission
Delay jitter		10 msec	Video telephony
		5 msec	JPEG video transmission
	Frame rate	30 frames/sec	NTSC format
Frame width		≤ 720 pixels	Video signal MPEG coded
	Frame height	≤ 576 pixels	Vertical size
	Color resolution	8 bit/pixel	Grayscale resolution of 256 colors
Compression ratio	2:1		Lossless compression of HDTV
	50:1		Lossy compression of HDTV
Decoded buffer		$\leq 376,832$ bits	MPEG related parameters

IMAGES - STITCHED TOGETHER



[Mosaic example](#)

[Panorama example](#)

IMAGES – STEREO



VIDEO

How do you describe video ?



creamedgeates.mpa

AUDIO

Audio Media is of various kinds

CD Quality (uncompressed)

Mp3 compressed audio



sound3-brubeck_takefive.mp3

Speech – (.wav)

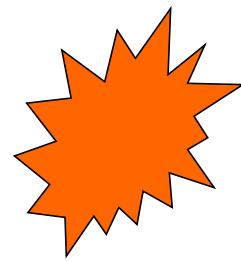
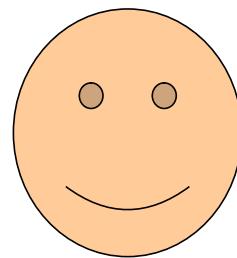


MIDI example – sound1-furelise.mid

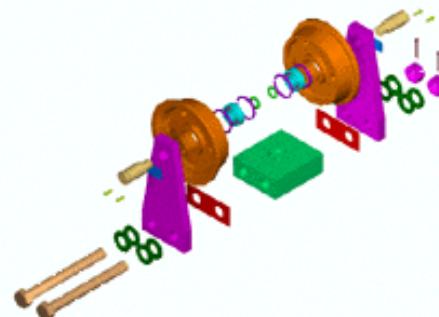
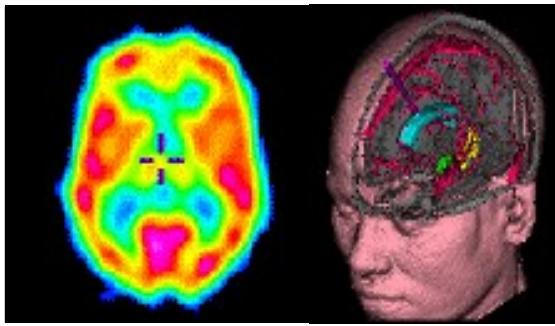


How do you describe audio ?

2D GRAPHICS



3D GRAPHICS



MEDIA TYPES – CONCLUSION

We have seen a lot of media types that are currently used; there may be others in future depending on

- Need for information
- Capture device technologies
- Rendering devices and technologies

Need for standards

- Many media types, having many formats
- Information has to be easily interchanged and displayed

BREAK



char.spiderman_small.mov

EXAMPLES IN MULTIMEDIA

ImmersiveMedia – Interactive Video

Commented [PH1]:

Augmented/Virtual Reality

Industry Example, Oculus VR, Holoportation

Movies, Animation & VFX Pipeline

Performance capture technologies

Display Technologies- Auto stereoscopic Displays

Synthesizing Obama

Multiplayer Gaming

Research Progress – the Visual Microphone, Cocktail Party,

INHERENT QUALITIES OF MULTIMEDIA

Digital Always

Mixture of different media types

Interactive

Multimedia Data is huge

Real Time Issues

Synchronization Issues

- **Intra media Time dependencies**
- Inter media Time dependencies**

BACK TO EXAMPLES AGAIN

Reading a newspaper .

Describing a Picture to your friend .

Video Game Playing and Multiplayer Game .

Riding a bicycle .

Video Conferencing .

Visiting your doctor .

Watching Television .

Assembling a car in a garage .

Listening to Radio .

Having a phone conversation .

MULTIMEDIA CLASSIFICATIONS

Static Vs Dynamic

Type - Real time Vs Orchestrated

Linear Vs Nonlinear

Person-to-Person Vs Person-to-Machine

Distribution

- **Single user (CD ROM and Computer)**
- **Peer to Peer (Teleconferencing between two addresses)**
- **Peer to Multi Peer (Internet, Corporate Networks)**
- **Broadcast (Cable Network)**

FORCES DRIVING THE “MULTIMEDIA REVOLUTION”

Digitization of all information - text/audio/video documents, libraries, distributed nature of information

Evolution of data networks and communication standards with increasing availability of bandwidth on demand

Hardware - Faster processors, large capacity storage devices, smaller mobile computing devices.

Software - New algorithms, structures that deal with distributed queries

Better User Interfaces – hand held devices, sensors, displays

Digitization of virtually everything

Ubiquitous access of information

TECHNOLOGICAL ASPECTS

Organizing, Storage and Retrieval, Distribution, Playback

Techniques for compression

- Algorithms
- Standards

Communications Aspects

- Downloading and Streaming
- Synchronization
- Layering of Signals
- QoS – traffic, delays, packet loss, sync

Access to multimedia signals

- “natural” spoken language queries
- media conversion tools
- multimodal user interface
- distributed and collaborative access

COURSE MAP

Lecture 1 (Chapter 1) – Introduction to Multimedia and Course Map

Lecture 2 (Chapters 2 & 3) – Data Acquisition and Media Processing Basics

Signal Processing Basics, time/spatial and frequency domain analysis,
Sampling & quantization – aliasing effects. Bit rate
Representational aspects of media – images, audio, video, graphics.

Lecture 3 (Chapter 4) – Fundamentals of Color Theory & Displays

Color and Color Perception
Camera Color Calibration using CMFs
Color Spaces – types, uses and applications
Color Displays and Monitors – CRT, LCD, LED, OLED
Color Quantization

Lecture 4 (Chapter 6) – Information Theory and Generic Compression Techniques

Coding Theory

Lossless techniques – Huffman, Arithmetic, Lempel Zev etc.

Lossy techniques – Predictive Coding, Transform Coding, Wavelets, Hybrid etc.

Introduction to perceptual analysis

Lecture 5 (Chapter 7 and Research Papers) – Media Compression - Images

Representation Issues

Generic Image Compression algorithms – DCT, Wavelets, Fractals

Fourier Representation, DCT & Wavelet theory

Standards – JPEG, JPEG2000, GIF etc.

Image Dithering

Lecture 6 (Chapter 8 and Research Papers) – Media Compression - Video

Issues in representation, spatial & temporal domain.

Generic compression algorithms and analysis (MPEG techniques)

MPEG standards - MPEG1, MPEG2, MPEG4: various video Profiles and AVC

ITU standards – H.261, H.263, H.264, H.265 (HEVC)

Lecture 7 (Chapter 9 and Research Papers) – Audio Processing

Representation and capture Issues
Generic compression algorithms and analysis (MPEG techniques)
MPEG (1, 2, 4) standards – mp3, AAC, CELP
ITU standards – G.72x
Dolby AC3, AC5
Surround Sound, THX, Spatial Audio, Dolby Atmos

Lecture 8 (Chapter 10 and Research Papers) – 2D/3D Graphics Content Creation, 3D Compression & Recent Trends in 3D

Representation issues
Geometry Transformations in 2D and 3D
Rendering Pipeline – modeling, lighting, transformations, scan line
Animation techniques
Special Effects & Gaming Technology discussions
3D Compression
Modern applications of computer graphics and computer vision – image based rendering, panoramic images and cameras
3DTV, stereoscopic content

LECTURE 9 - Media Security & Digital Rights Management

Watermarking – definition, generic schemes, specific to MPEG world

Encryption – requirements, common rules, encryption related to MPEG world

DVD Encryption rules

Watermarking/Encryption Architectures – digital movie distribution pipeline, session based architectures

Term Exam

Lectures there after to be held at ICT

Open House at ICT

Real Case studies from the Industry

Blending CG and Real Imagery – geometrically & photometrically

Digital Characters and Virtual Actors

Light Stage Data Acquisition

Advanced Technologies to create virtual actors

Natural Language Queries

Virtual and Augmented Reality

Multimodal Media Analysis

Multimedia Metadata, MPEG7 and Metadata Management

Standards of Metadata – MXF, TV-Anytime, Dublin Core,

Examples of multimedia databases

Other Relevant Areas to be covered if we have time

MPEG4 & Applications, MPEG 21 Frameworks

- Introduction as a object oriented framework
- Representation Features – Audio Visual Objects, Scene Graphs
- Compositional, Synchronization & Delivery Features
- Compression features of each media object representation
- Applications around MPEG4, MPEG DASH
- MPEG 21 – distribution of content over a variety of networks

MPEG 21

- MPEG 21 – distribution of content over a variety of networks
- Digital Items and Digital Item Transactions across different networks

Multimedia Frameworks and Industry wide Multimedia Deployments

Current Trends – MPEG DASH, HEVC, DCI

Industry Outlook & Job Scenarios, Discussions on the future of multimedia ...