EE3414
Multimedia Communication Systems - I

Course Overview

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Course Overview

• A University Sequence Course in Multimedia Communication Systems
  – Introduces basic techniques for multimedia signal processing and communications
  – Discusses principles of real-world communication systems and standards.
• Part I (EE3414)
  – Speech, audio and image processing and communications
  – Wired ad wireless telephone networks
• Part II (EE4414)
  – Video processing and communications
  – Television systems, Audio/video over Internet
Course Requirements

- Two 2-hour lecture per week
  - 0.5 ~1 hour per week for recitation/review
  - Some lecture hours are used for experiment
- Weekly/biweekly homework assignment
  - Discussion/team work encouraged. Not counted towards final grade
- Weekly/biweekly quizzes
  - Chosen from homework problems
- Two exams (2 hours each, non-cumulative)
- Require a team project (2 people)
- Grading:
  - 1\textsuperscript{st} exam: 30\%, 2\textsuperscript{nd} exam: 30\%, Project: 20\%, quizzes+labs: 20\%
Project Requirement

- Requires a project by a team of 2 students
- Project type:
  - Reading/survey on a technical or system development, possibly including downloading and testing performance of public-domain software.
  - Implementing in software (in C, MATLAB or JAVA) an algorithm for speech/audio/image/video processing
- Project subject:
  - See list of suggested project topics
  - You can choose something outside the suggested list
  - See list of projects done in previous semesters
Project Phases

• Project Planning:
  – Deciding on partners and selecting project topic, conducting preliminary research on the topic, writing project plan (including list of tasks and deadlines and responsible persons)
  – Project Plan Due: 4th week
• Midterm Project Report: 9th week
• Final Project Presentation: 14-15th week (date of final)
• Final Project report: same date as presentation
• See “project guideline” in course homepage for more detail
Other Logistics

• Prerequisite
  – Computer programming experience (CS1114), basic calculus (MA1022)

• Textbook:
  – We have not been able to find a suitable textbook that covers all the topics of the course at an appropriate level. We will be distributing excerpts from selected books or lecture notes when more depth is required.

• Instructors:
  – Yao Wang (email: yao@vision.poly.edu, LC256)
  – Guest lecturers
  – Teaching Assistant

• Office Hours:
Overview of Multimedia Communication Systems

- Example systems
- Technology behind
- Multimedia standards
- Topics to be covered
Example Systems

- Legacy systems
  - Plain old telephone (wired phone)
  - Facsimile
  - Analog Broadcast television through terrestrial channel or cable

- Modern/emerging systems
  - Wireless phone (Cellular phone)
  - IP phone
  - Picture phone
  - Teleconferencing
  - Distance learning
  - Music and image downloading from the web
  - Video streaming / Video-on-demand
  - Digital television through terrestrial, cable, satellite, Internet
  - On-line games
  - Etc…
Technology Behind

- A multimedia communication system involves the following three phases:
  - Content Creation -> Distribution -> Presentation
- Each process requires a set of critical technologies
- Multimedia technology refers to the combination of all technologies in the above three processes.
- Successful deployment of a multimedia system requires development of “good” standards
## Critical Technologies

<table>
<thead>
<tr>
<th>Process</th>
<th>Critical Technological Components</th>
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<tbody>
<tr>
<td><strong>Content Creation</strong></td>
<td>Audio/Video Capture (digitization)</td>
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<td>Editing &amp; Processing</td>
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<td>Authoring Tools</td>
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<td>Information Retrieval</td>
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<td>Compression</td>
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<td><strong>Distribution</strong></td>
<td>Telecommunications</td>
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<td>Storage</td>
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<td>Database Management</td>
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<td><strong>Presentation</strong></td>
<td>Display</td>
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<td>Human-Computer Interface</td>
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<td>Content-based Browsing and Retrieval</td>
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<td>Graphics and Virtual Reality</td>
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Data Rates of Multimedia Signal

<table>
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<tr>
<th>Multimedia Content</th>
<th>Size</th>
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<tbody>
<tr>
<td>One Page of Text</td>
<td>2 KB</td>
</tr>
<tr>
<td>One 640x480 24-bit color still image</td>
<td>900 KB</td>
</tr>
<tr>
<td>Voice (8 Khz, 8-bit)</td>
<td>8 KB/second</td>
</tr>
<tr>
<td>Audio CD DA (44.1 Khz, 16-bit)</td>
<td>176 KB/second</td>
</tr>
<tr>
<td>Animation (320x640 pixels, 16-bit color, 16 frame/s)</td>
<td>6.25 MB/second</td>
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<tr>
<td>Video (720x480 pixels, 24-bit color, 30 frame/s)</td>
<td>29.7 MB/second</td>
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Compression (or coding) is required to reduce the data rate for efficient storage and transmission of multimedia data

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Image Coding Standards

- G3, G4: facsimile standard
- JBIG: The next generation facsimile standard
- JPEG: For coding still images or video frames.
- JPEG2000: Improved version of JPEG, offering better quality at lower bit rate, progressive coding, error resilience.
- Lossless JPEG: for medical and archiving applications.
Standards for Entertainment Applications

- MPEG-1: For coding of VHS resolution (SIF) video and audio at 1.5 Mbps -> video CD.
- MPEG-2: For coding of NTSC resolution (CCIR601) video and audio at 3-10 Mbps -> DVD, direct broadcasting satellite (DBS), terrestrial broadcasting digital TV.
- MPEG-4: Enable content based accessibility in addition to compression capability.
- H.264/MPEG AVC: A video coding standard that improves over MPEG4 video
Standards for Audio-Visual Conferencing

- H.320: For video conferencing over ISDN at rate px64 Kbps, \( p = 1 \) to 30.
- H.323: For video conferencing over packet-switched networks with non-guaranteed quality of services (e.g. Internet), 16 Kbps -> 2 Mbps
- H.324: For video phone/conferencing over regular phone lines or wireless cellular networks through modems (as low as 28.8 Kbps).
- T.120: Enable data/application sharing in H series conferencing applications
Audio Coding Standards

- G.72x: Speech coding for wired/wireless phones and for audio-visual conferencing
- AAC: MPEG-2 audio coding
- MIDI (Musical Instrument Digital Interface) - representing the frequency and duration of each music note by a symbol. The characteristics of each instrument are stored as digital data.
- Wavetable synthesis: Musical instruments are prerecorded. The stored sounds are blended to match actual sound.
Objective of This Course Sequence

• Lectures and demos:
  – Introduce basic principles of signal processing, communication, and networking, through real-world systems and applications
  – Provide exposures to multimedia processing and communication technology and standards

• Experiments:
  – Provide hands-on experience for processing multimedia signals (through experiments involving Matlab and other softwares)

• Term project:
  – Gain in-depth understanding of a chosen topic
  – team-work, verbal/written communication, project planning
Topics in Part I

• Speech and Audio Processing:
  – Frequency domain characterization and processing of signals
  – Speech and audio sampling, quantization, filtering
  – Speech and audio coding principle and standards

• Image Processing:
  – Color perception and representation
  – Basic image processing tools (contrast enhancement, noise removal, resizing)
  – Image coding principle and standards

• Communication and Networking:
  – Analog modulation and multiplexing, digital modulation
  – Basics of communication networks
  – Wired and wireless telephone systems
Topics in Part II

- Video Processing
  - Analog video format (raster scan, interlaced vs. progressive)
  - Digital video format
  - Video coding principles and standards
- Television system:
  - Analog: from B/W to color
    - Audio/video multiplexing, modulation
  - Digital TV
- Video over networks
  - Video streaming
  - Video phone/conferencing
  - Internet protocols for time-sensitive applications