WOCC 2005 Special Session on Interactive Multimedia

An Overview of Technologies for E-Learning Application

Ying Li
IBM T. J. Watson Research Center
yingli@us.ibm.com
Why e-Learning (Remote/Distance Education, Distance Learning, Web-based Learning)?

Reasons for e-Learning:

• For individuals that use e-Learning:
  • Cost saving: time, travel
  • Flexible schedule, self-driven, and self-paced, on-demand

• For universities that provide distance education:
  • Can attract more students
  • To enable students to access their classes anytime, anywhere, even for on-campus students
  • USC: 90+ courses available in every fall and spring semester, 25+ courses for summer. MS degrees in various majors

• For industrial organization:
  • Knowledge sharing (e-seminars, tutorials)
  • Employee skill training
  • Customer/partner/supplier education on company products or services
  • According to an international data corporation’s report, the corporate e-Learning market will grow to 24 billion
A confluence of trends and events have created increased demand for e-learning across all industries....

**Evolution and Convergence of Technology**
(broadband, rich media, maturing KM and collaboration technologies...)

- **World Events**
  - Strict limits on travel (9/11, SARS)

- **Economic Downturn**
  - Focus on cost and ROI
  - NCLB, WDI

- **Public Policy**
  - Learning as a strategic lever

- **Knowledge Economy**
  - Aging workforce, new generation of learners

- **Demographics**
  - Accelerated Adoption of e-Learning

**accelerated adoption of e-learning**
e-Learning Trend …

➢ Over the next 3 years, companies will make significant investments in e-learning

By 2005, except for web infrastructure, e-mail and search engines, e-learning will be the mostly used corporate application on the web (0.7 probability)
(source: Gartner)
An E-Learning System

Course Objectives
Understanding the components of SWIG

Content Capture
- Plain recording
- Enhanced recording (PTZ camera, microphone array, speaker tracking)

Video Content Analysis
- Inter-media content synchronization
- Intra-media content analysis

Archive

Content Delivery
- ROI
- Keyframe
Outline

- Content Capture
- Content Analysis, Indexing and Retrieval
- Content Delivery
- E-learning Standards
E-learning Content Capture

- Plain recording
  - Seen in not well-equipped rooms; usually with one camera, mainly focusing on the instructor; no special attention paid to capture audio

- Enhanced recording
  - Multiple cameras or PTZ (Pan-Tilt-Zoom) cameras
  - Panoramic video capture
  - Multiple content sources (instructor, slides, whiteboard, notes)
  - Microphone arrays
  - Speaker tracking enabled
  - (Semi)-automatic video directing
Panoramic Video Capture With PTZ/Multi- Cameras

- PTZ cameras could be controlled automatically
  - Microphone arrays
  - Speaker tracking
- Enable (semi)-automatic video directing
  - Applying pre-defined video production rules: camera positioning, audience tracking, speaker tracking, shot transition
Controlling PTZ Camera

- Using microphone arrays
  - To locate sound source: instructor, audience
  - To direct the PTZ camera

- Tracking speakers
  - Use visual cues to locate speaker
    - Motion, face, gesture
  - Use light-weight hardware devices
    - Wearable ultrasonic beacons

CARMUL system, Kyoto University
Presentation Slide Capture

- Presentation slide: A major content source

- Two ways to capture slide content
  - Embed in the same video stream with other content sources
  - Output as a separate media stream
    - Pre-obtain slides from the presenter
    - Install a plug-in in the presenter’s machine
    - Screen-capture software
    - Dedicate a camera to capture slides and store them into a separate stream
Personal Notes/Handwriting Capture

- Excellent access points to lecture recordings

- Two ways to capture notes or handwritings
  - Separate media stream
    - NotePals, StuPad: compose notes on PDAs and upload to servers separately
  - Record notes with slides together
    - NoteLook, ZenPad, LecternII: compose notes on slides using tablet PC

StuPad, George Tech

NoteLook, FX Palo Alto
Whiteboard/Blackboard Content Capture

Two solutions

- Commercial electronic whiteboards
  - Automatically record time-stamped pen coordinates

- Image mosaics
  - Capture whiteboard with a PT camera and stitch frames to obtain high-resolution image
Outline

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Learning Content Analysis

- **Goal**: to facilitate convenient content access, browsing and retrieval

- **Two types of analysis**
  - **Inter-media Content Synchronization**
    - Link the slide/whiteboard source with the video stream
    - E.g. Identify the point in video stream where a particular slide is presented
    - Link notes/handwritings with the video or slide
    - Synchronize audio with video
  - **Intra-media Content Analysis**

The City University of NY
Intra-media Content Analysis

- Activity detection and recognition
  - Gesture (hand raise)
  - Discussion (Q&A, classroom discussion)
- Speaker identification
  - Face, voice
- Video content identification
  - Speaker, audience, slide, whiteboard, web-page, notepad
- Narrative structure extraction and content indexing
- Video summarization
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Learning Content Delivery

- Many e-learning systems support **on-demand** and **real-time** streaming of lectures with synchronized voice, video, slides, etc.
- Some systems support **real-time** and **interactive** sharing of slides and whiteboards
  - *Virtual auditorium*: supports dialog-based distance learning and real-time monitoring
  - *Virtual classroom*: to simulate a real classroom for remote students using interactive Q&A, real-time audio and video
Mobile Learning

- Mobile learning is becoming popular …
- Mobile transmission of e-learning data is challenging
  - Rich media content with limited bandwidth

- **Solution**: content-aware mobile transmission
  - Transmit salient content regions (ROI)
  - Transmit optimal (compressed) keyframes with adaptive feedback control
  - Transmit video summary

University of South Carolina
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e-Learning Standards

- The Department of Defense (DoD) established **Advanced Distributed Learning** (ADL) initiative in 1997
  - **Purpose**: To ensure access to high-quality education and training materials that can be tailored to individual learner needs and made available whenever and wherever they are required
  - Developing strategy for using learning and information technologies to modernize education and training on the Web, and to promote cooperation between government, academia and business to develop e-learning standards

- A **Sharable Content Object Reference Model** (SCORM) was defined by ADL to enable the interoperability, accessibility, durability and reusability of Web-based learning content
SCORM: Sharable Content Object Reference Model

- SCORM is built on many e-Learning standardization efforts
  - IMS Global Learning Consortium
  - The Aviation Industry Computer-based training committee (AICC)
  - The IEEE Learning Technology Standards Committee (LTSC) – Learning Objects Metadata (LOM) specification
  - The Alliance of Remote Instructional Authoring & Distribution Networks for Europe (ARIADNE)

- SCORM LOM overview
  - Nine learning object metadata categories from IEEE LOM specification
    - General, Lifecycle, Meta-metadata, Technical, Educational, Rights, Relation, Annotation, and Classification
  - IMS’s XML binding specification for metadata representation
  - Describe three content model components
    - Asset, Sharable Content Object (SCO), Content Aggregation
IMS Content Packaging

- IMS content packaging: to provide a standardized way to exchange digital learning resources between different systems or tools

- Single hierarchical organization

- One resource entry for each asset

- Physical files include a Content file and a Metadata file for each asset and any supporting files
SCORM and MPEG

SCORM LOM  ↔  MPEG-7

IMS Content Packaging  ↔  MPEG-21
Future Research Directions in e-Learning

- Convenient and effective e-learning content authoring (e-classroom setup, automatic/smart learning video acquisition, creation, synchronization and editing)
- Integrating multiple media modalities (such as visual/face/gesture/gaze, audio/speech, text/handwriting, motion) to better understand the learning content
- e-Learning applications: content summarization, browsing and retrieval
- Learning content sequencing
- Collaborative e-learning