Fundamentals of Multimedia

（多媒体技术基础）

Authored by Ze-Nian Li Mark S. Drew

Lecturer：Lu Dongming
(鲁东明)

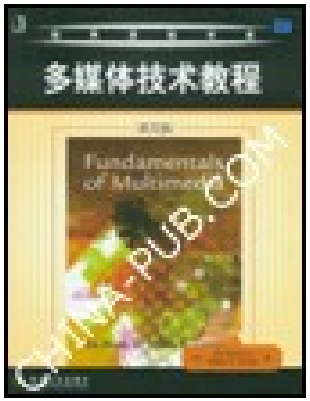
Textbook and references

- **Textbook:**
  - **Fundamentals of multimedia**

    （多媒体技术教程），

    Ze-Nian Li, Mark S. Drew（著），

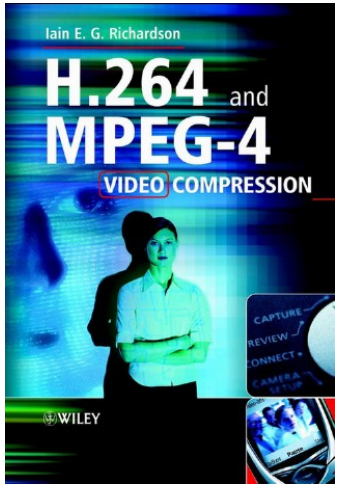
    机械工业出版社，2004年7月



Textbook and reference (Cont.)

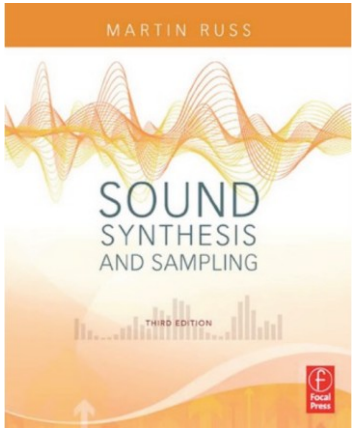
- **Reference：**
  - 多媒体技术基础(第三版)，林福宗著，清华大学出版社，2009.1

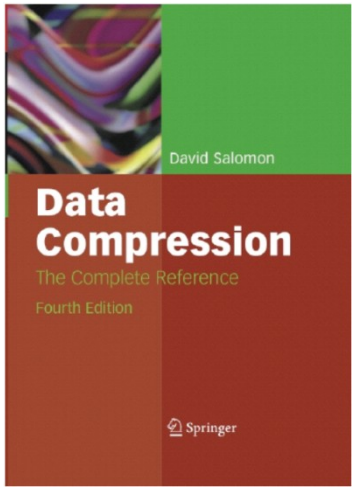
  - **H.264 and MPEG-4 Video Compression Video Coding For Next Generation Multimedia, Iain E.G. Richardson, Wiley press, 2003**



Textbook and reference (Cont.)

- **Reference (Cont.):**
  - **Sound Synthesis and Sampling (Third Edition), Martin Russ, Focal Press, 2008**
  - **Data Compression: The Complete Reference (Fourth Edition), David Salomon, Springer, 2007**
  - **Please checkout http://netmedia.zju.edu.cn/multimedia2013**





About the course

Course Website：
http://netmedia.zju.edu.cn/multimedia2013/

TA: Yuqi Li– fenghuoqilin@gmail.com
(李裕麒 博士生)

Audience and Prerequisite

- **Main Audience**
  - **Undergraduate students from the College of Computer Science and Technology**
- **Prerequisite**
  - **With Programming experience and Some knowledge about Computer Network**

Teaching form and Evaluation

- Teaching form
  - Instructing with multimedia projector
  - Interaction, Homework
  - Programming Project

- Evaluation
  - Interaction / Homework/Project (25%)+ Mid-Term-Test (20%)+ Examination(55%)

Network & Media Laboratory

1. Introduction to Multimedia

1.1 The Outline; 1.2 History of Multimedia;

1.3 Multimedia Systems;

1.4 Typical Multimedia Software System;

1.5 Main Contents of this Course

1.1 Outline: What is Multimedia … ?

- **The meaning of "Multimedia"?**

Many quite different, even opposing viewpoints:

- **A PC Vendor**
- **A Consumer Entertainment vendor**
- **A Computer Science Student**

1.1 Outline: What is Multimedia … ?

PC Vendor

- Audio Function
- DVD-ROM Driver
- Multimedia Processor…

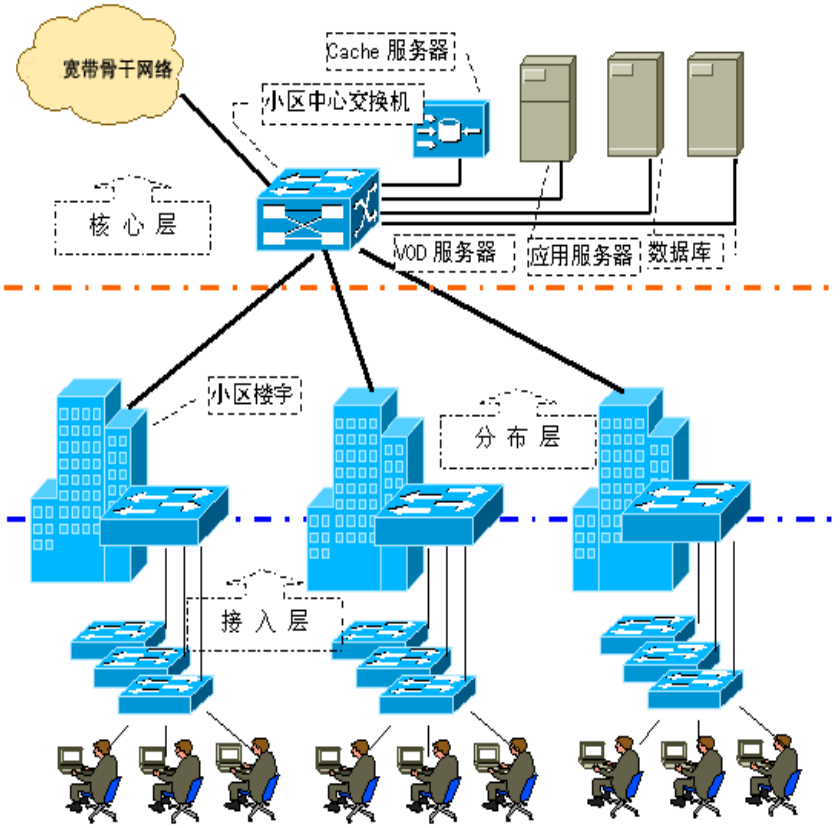
3D Display card

Audio Card

1.1 Outline： What is Multimedia … ?

A Consumer Entertainment Vendor

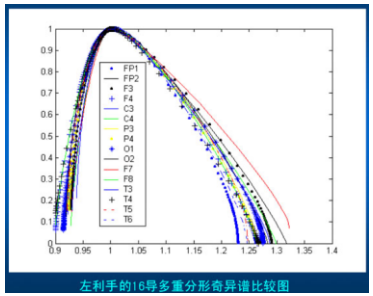
- Interactive cable TV
- Service over High-speed internet



1.1 Outline: What is Multimedia … ?

A Computer Science Student

- About **Multiple Modality** information application:
- Text, Image, Graphics, Animation ,Video, Sound…



1.1 Outline： Typical definitions

- **Multimedia definition： The Technology to Collect, Process, Edit, Store and Present more than two medias at the same time**
  - **Including text, image, graphics, animation and moving pictures.**

- **A more general definition: The independent machine which is able to create, represent, process, store, retrieve the information in various medias**

1.1 Outline: Category of medias by CCITT

- **Perception Medium：Directly make human have the feeling to the media**
  - **Including human's speech, music and various sound from natural environment, the moving image, graphics, curve, animation and text.**

- **Representation Medium：The middle method to transfer to feeling, to effectively transfer from one place to another**
  - **Including various audio encode, music encode, image encode, text encode, moving picture encode and still picture encode.**

CCITT：International Telegraph and Telephone Consultative Committee

1.1 Outline: Category of medias by CCITT

- **Presentation Medium：conversion between electronic signal and feeling medias**
- **Two kinds：**
  - **Input medium（including keyboard, mouse, camera, Scanner, light pen, micro-phone）**
  - **And output medium（including display, printer, drawer）**

1.1 Outline: Category of medias by CCITT

- **Storage Medium: storing the medias, in order to access the medias in local or remote place as needed**
  - **Hard disk, floppy disk, blue-ray disk, tape,…**

- **Transmission Medium: Transmission of the media from one place to another.**
  - **Telephone line, Twisted line, cable, fiber, radio, …**

1.1 Outline: Multimedia application

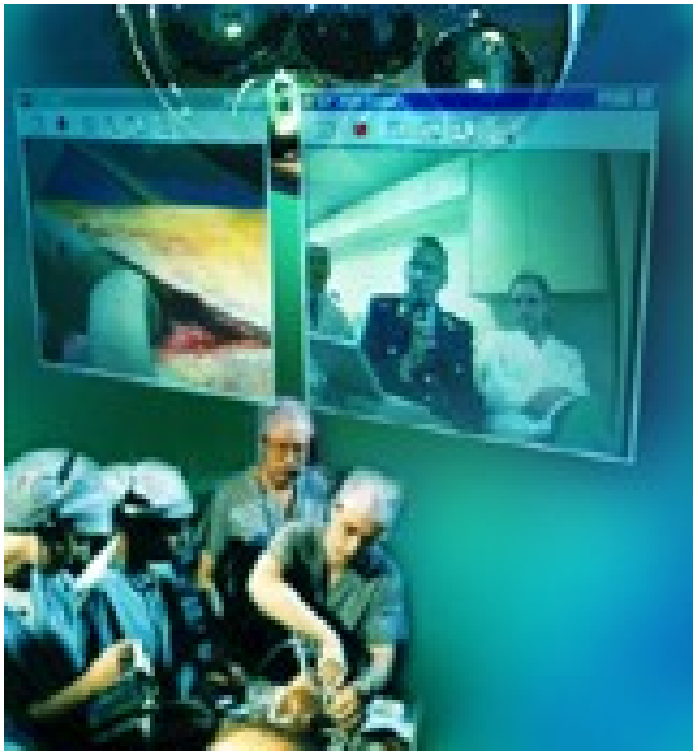
- **Education**

Video teleconferencing

Distributed Lectures for Higher Education

1.1 Outline: Multimedia Application

- **Medicine**

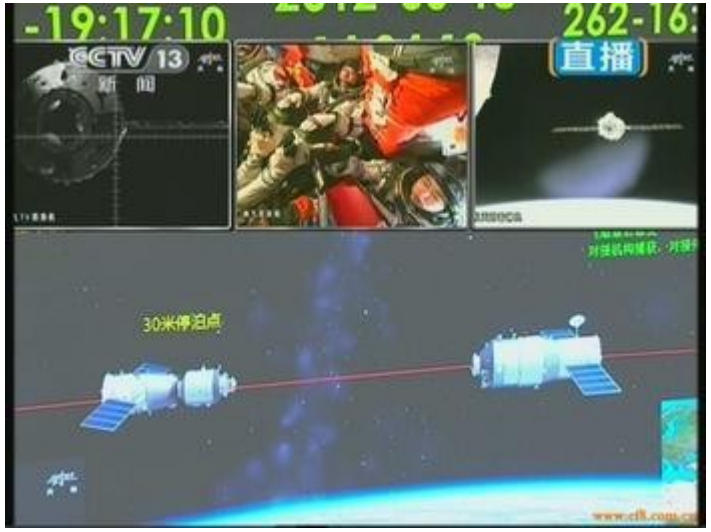


Telemedicine

1.1 Outline: Multimedia Application

- **Spaceflight**

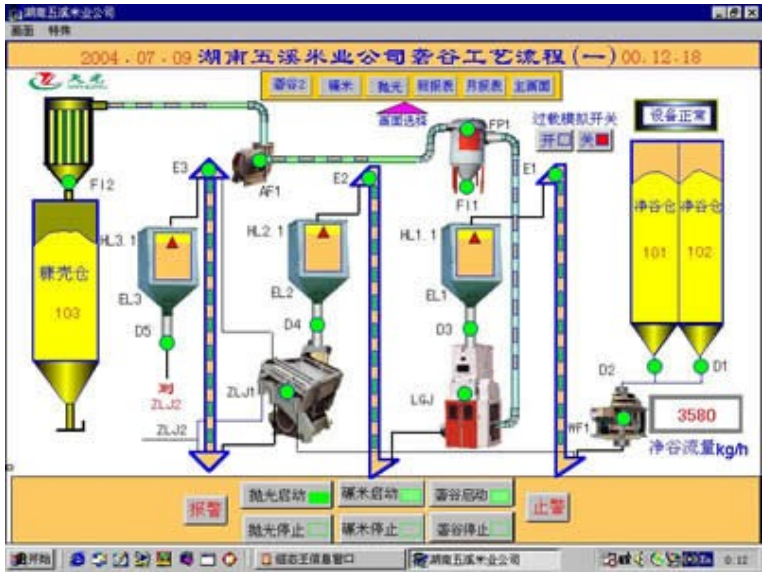
Armstrong on the moon

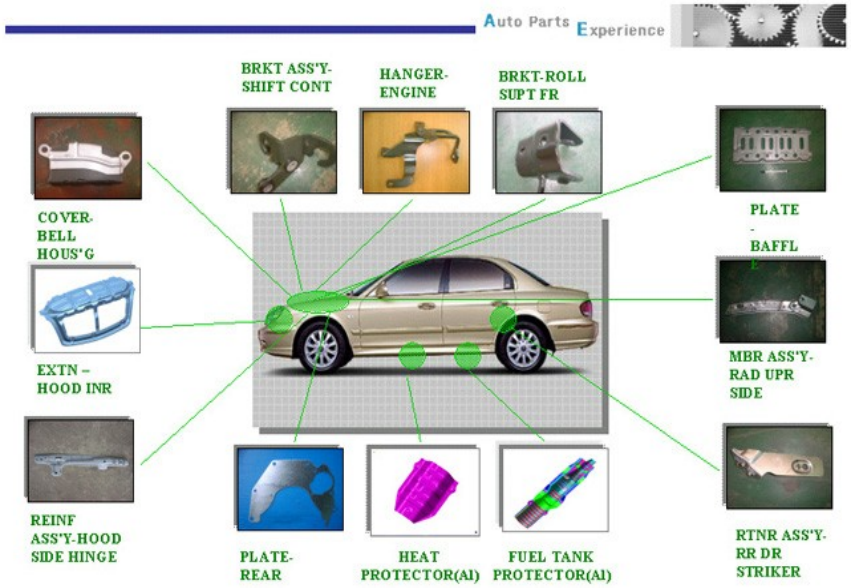


Shenzhou No. 9

1.1 Outline: Multimedia Application

- **Industry manufacture automation**





Manufacture Automatic Monitor system **Automobile Model Design**

1.1 Outline: Multimedia Application

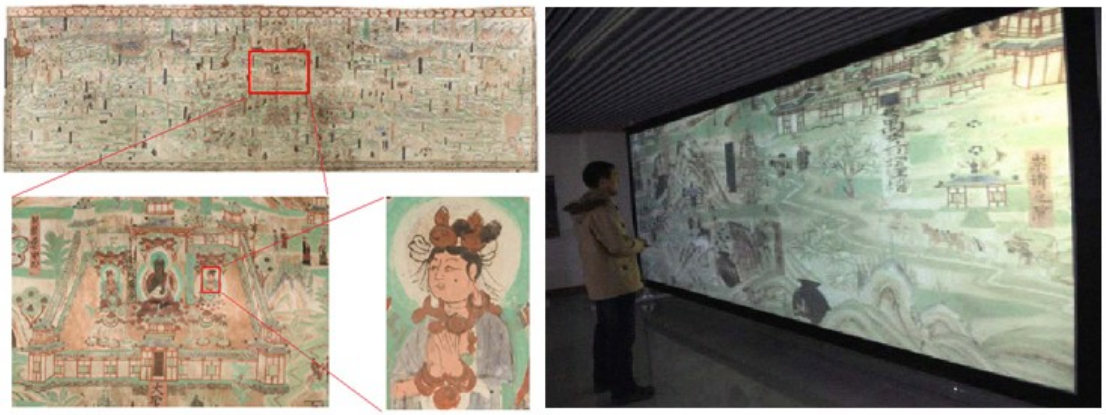
- **Education**

Augmented Reality

Virtual Reality

1.1 Outline：Multimedia Application

- **Culture and Arts**



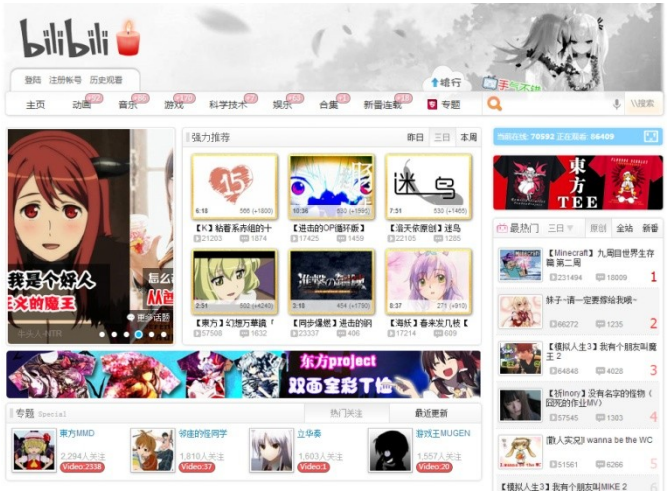
Ultra-high resolution Dunhuang Mural browser

Immersive Display

1.1 Outline： Multimedia application

- Game and Entertainment

Online Video Game



Video-On-Demand

1.1 Outline：Multimedia Application

- **Mobile Application**

App Market

Google Glass

1.1 Outline： Multimedia VS. Computer Science

- More and more computer fields relevant to multimedia
  - Operation System
  - Networks
  - Vision Process
  - Information Retrieval
  - Real-time Systems…

1.2 History： Beginning of the idea

- **Newspaper**： **start of communication with media**
  - **The first Public Media**
  - **Using text, graph and table**

- **Film without sound**: **1910-1927, ended by the Jazz Singer**
  - **Jazz Singer (Music film), the first film with sound**
  - **Thomas A. Edison invented the moving camera in 1887**

1.2 History： Beginning of the idea

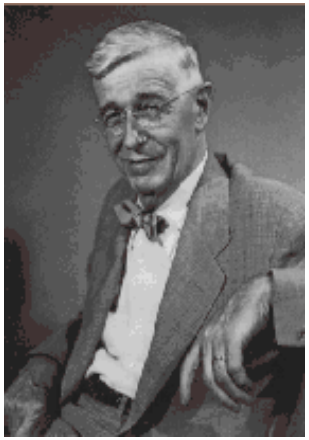
- Radio：became the main media of broadcasting
  - Guglielmo Marconi (Italy)
  - Transmit radio signal in1895，won Nobel Physics prize in Nov. 1909

马可尼，G.

- TV：The innovative media in 20th century
  - Changed the pubic communication all over the world

1.2 History： Initial technology

- 1945 **Vannevar Bush**: propose one Hypermedia System relevant concept -- “Memex”
  - http://www.cs.sfu.ca/CC/365/mark/material/notes/Chap1/VBushArticle/



Vannevar Bush

- 1960s **Ted Nelson started** Xanadu project， The first test to develop **Hypertext System**
  - http://en.wikipedia.org/wiki/Project_Xanadu
  - **Ted Nelson， American sociologist, philosopher, Forerunner of information technology,**
  - **Put forward “hypertext” 1n 1963**

1.2 History： Initial technology

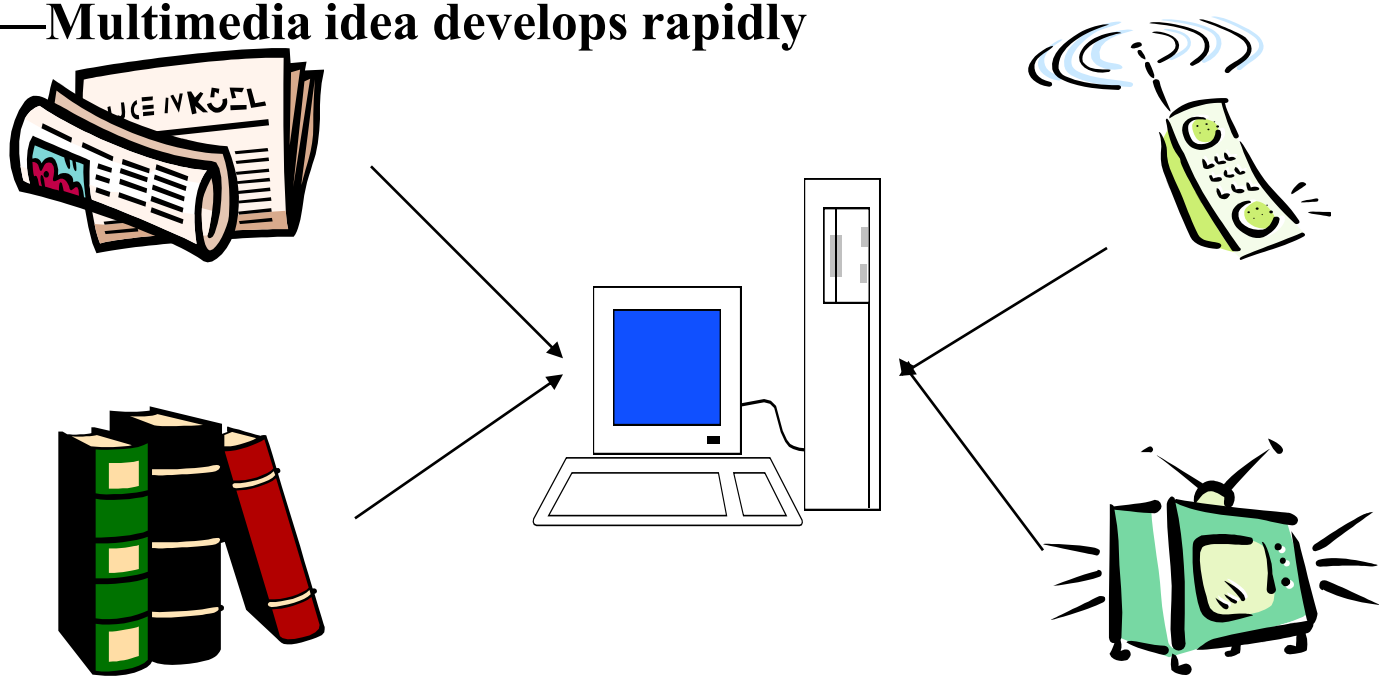
- 1967 **Nicholas Negroponte**， set up **Architecture Machine Group in MIT**
  - MIT professor 、MIT Media Lab Chairman
- 1968 **Douglas Engelbart**， showed another hypertext system -- “On-Line System” （NLS）
  - **Douglas Engelbart, 32th touring prize (1997) winner , the inventor of computer Mouse**

The first Mouse

  - **Some important idea：hyperlink，teleconference，text processing，email，window software，help system**

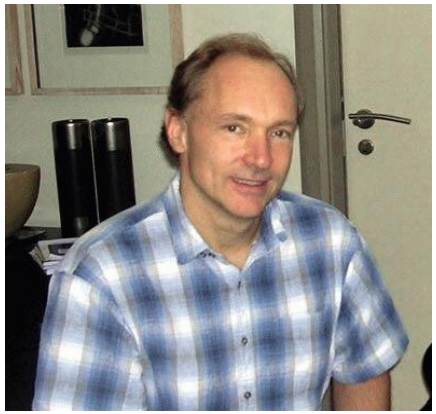
1.2 History: Technology birth

- 80's 20th century: Input sound, image, graphics into computer as new information carriers, process and output
  - Make computer application more wider, easier to use
  - ——Multimedia idea develops rapidly



1.2 History: Technology growing up

- 1985-Negroponte and Wiesner set up the MIT Media Lab
  - World First-level digital video and multimedia research institute
- 1989-Tim Berners-Lee suggested World Wide Web to cern
  - Berners-Lee, the father of "WWW",
  - Now leading the non-profit organization W3C.



Tim Berners-Lee

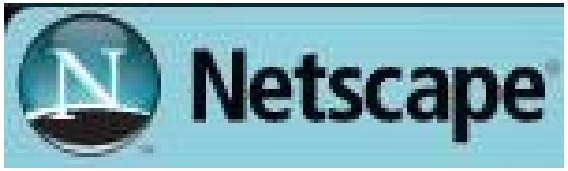
- 1990-Kristina Hooper Woolsey set up Apple Multimedia Lab with 100 persons

1.2 History: Technology Mature

- **1991-MPEG-1 adopted as International digital video standard**
  - In 1990s，MPEG-2，MPEG4 and other MPEG-X were proposed
- **1992-JPEG was adopted as international digital image standard**
  - Improved to JPEG2000;
- **The same year，the MBone appeared**
  - MBone (Multicast Backbone) was a virtual network set up for Internet engineering task group's (IETF) video conference
  - It shares the same physical media with Internet, supporting audio, video and whiteboard

1.2 History: Technology Mature

- **1993: Illinois University proposed the NCSA Mosaic**
  - NCSA Mosaic (TM) was developed by Illinois university National Center of Super computing Application (NCSA)
  - X-Windows based Browser, the ancestors of MS IE, Netscape as well other web browser



- **1994: Jim Clark and Marc Andresen developed the WWW browser Netscape**
  - Netscape had ever been in the leading position in web browser fields and was defeated by Internet Explorer of Microsoft
  - By Nov. 1998, Netscape was purchased by AOL

1.2 History: Technology Development

- 1998, handheld MP3 devices first made inroads into consumer
- 2000，WWW size was estimated at over 1 billion pages
- 2001，MPEG7 was formulated
- 2005, Part13 of MPEG-21 was formulated and SVC (scalable video coding) was announced
- 2007, The first generation iPhone was released
- 2008, Parts of HTML5 have been implemented in browsers
- 2009,Android become the top-selling smartphone platform.
- …

1.2 History: Technology Research

- **Multimedia processing and coding**
  - Multimedia content analysis
  - Content-based multimedia retrieval
  - Multimedia security
  - Audio\image\video processing, compression, and so on

- **Multimedia system support and networking**
  - Network Protocols, internet, operating systems
  - Server and clients, quality of service (QoS) and Databases
  - Network Architectures for multimedia transmission (CDN, P2P)

1.2 History: Technology Research

- Tools, end system and application
  - Hypermedia systems, user interfaces,
  - Authoring system, multimodal interaction
  - And integration
  - Multimedia education, virtual environments
  - Multimedia systems on mobile devices

1.2 History: Applications

- Camera-based object tracking technology
  - Develop control systems for industrial control, gaming, and so on
- 3D motion capture
  - Produce realistic animated models
- Multimedia applications aimed at handicapped persons
  - Poor vision and the elderly
- Digital fashion
- Electronic House call system
- Behavioral science model

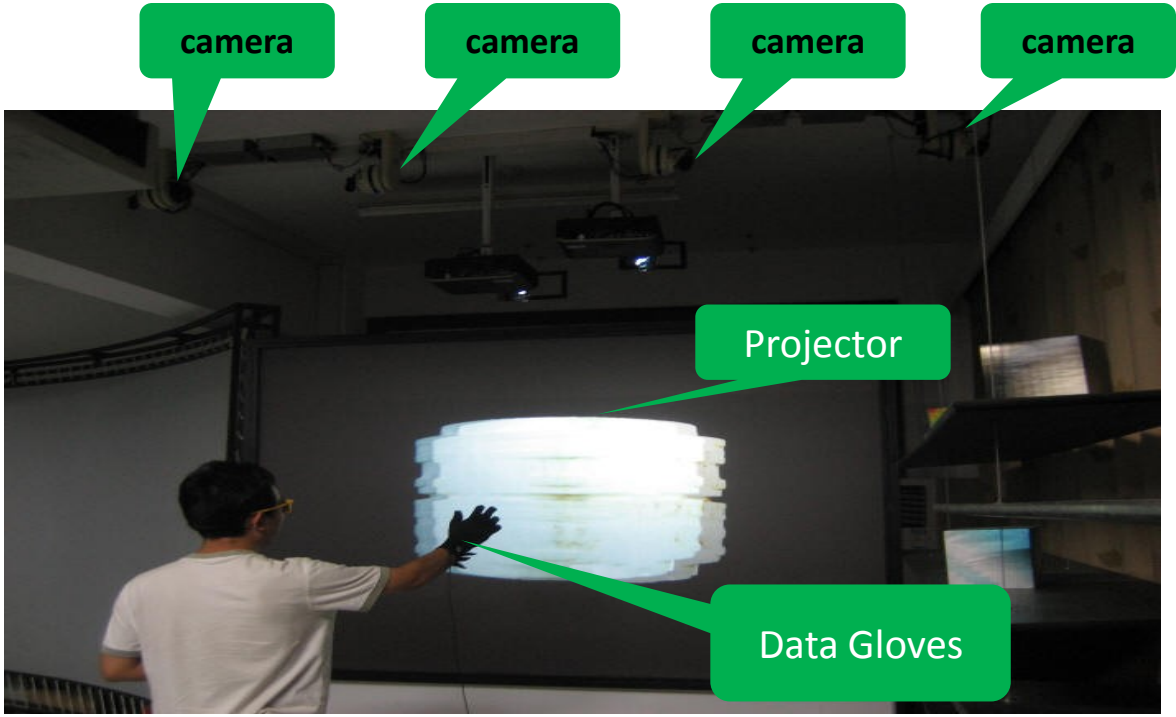
1.2 History: Applications

- **Camera-based object tracking technology**
  - **Immersive interactive browsing in digital museum**
  - **Vision based tracking**

—Feature Acquisition

—Multi-Source Vision Data Computing

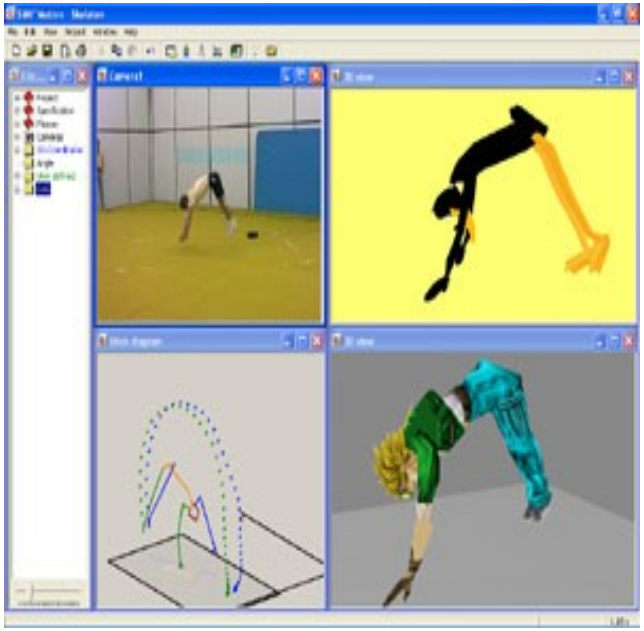
—Interactive Output

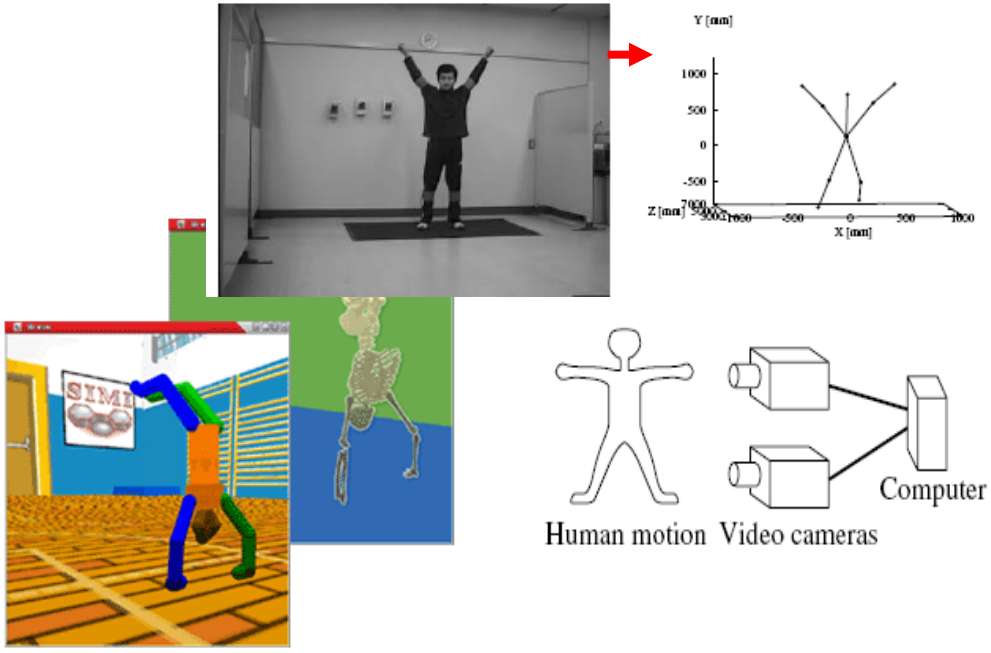


1.2 History: Applications

- 3D motion capture

  generate realistic animation model





3D motion capture

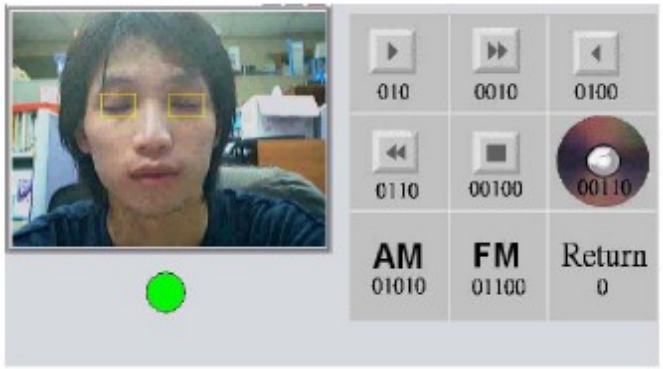
1.2 History: Applications

- **Multimedia Applications Aimed at Handicapped Persons**

Tracking the action of eyes.

Right figures：generate 8*8+2=66 actions； One button is return

An Automatic Eye Wink Interpretation System for the Disable



1.2 History: Applications

- **Digital fashion**

Mobile

PAD

XBOX

PSP game

Digital Camera

1.2 History： Applications

- **Digital fashion**

Music Safa:

By American designer
Giongkun Wuqiongkun

1.3 Multimedia Systems: Concept

- A **Multimedia System**
  - A system capable of processing multimedia data and applications.
  - A **system** is characterized by the processing, storage, generation, manipulation and rendition of Multimedia information.

1.3 Multimedia Systems: Features

- Four basic characteristics:
  - Multimedia systems must be **computer controlled**.
  - Multimedia systems are **integrated**.
  - The information they handle must be represented **digitally**.
  - The interface to the final presentation of media is usually **interactive**.

1.3 Multimedia Systems: Challenge

- **Challenges for Multimedia Systems**
  - **Distributed Networks**
  - **Temporal relationship between data**
    - **– Render different data at same time — continuously.**
    - **– Sequencing within the media**

      playing frames in correct order/time frame in video
    - **– Synchronization — inter-media scheduling**

      E.g. Video and Audio — Lip synchronization is clearly important for humans to watch playback of video and audio and even animation and audio.

      Ever tried watching an out of (lip) sync film for a long time?

1.3 Multimedia Systems: Key Issues

- **The key issues multimedia systems need to deal with here are:**
  - How to represent and store temporal information
  - How to strictly maintain the temporal relationships on play back/retrieval
  - What process are involved in the above
  - Data has to represented digitally — Analog–Digital Conversion, Sampling etc.
  - Large Data Requirements — bandwidth, storage

Data compression is usually mandatory

1.3 Multimedia Systems: Desirable Features

- The following feature a desirable **(if not a prerequisite)** for a Multimedia System:
  - **Very High Processing Power —** needed to deal with large data processing and real time delivery of media.
    Special hardware commonplace.
  - **Multimedia Capable File System —**needed to deliver real-time media — e.g. video/Audio Streaming.
  - **Special Hardware/Software needed –** e.g. RAID technology.
  - **Data Representations —** File Formats that support multimedia should be easy to handle yet allow for **compression/decompression** in **real-time**.

1.3 Multimedia System : Desirable Features

- **Efficient and High I/O —**input and output to the file subsystem needs to be efficient and fast. Needs to allow for real-time recording as well as playback of data.
  e.g. Direct to Disk recording systems.
- **Special Operating System —**to allow access to file system and process data efficiently and quickly. Needs to support direct transfers to disk, real-time scheduling, fast interrupt processing, I/O streaming etc.
- **Storage and Memory —** large storage units (of the order of hundreds of Tb if not more) and large memory (several Gb or more). Large Caches also required and high speed buses for efficient management.
- **Network Support —** Client-server systems common as distributed systems common.
- **Software Tools —** user friendly tools needed to handle media, design and develop applications, deliver media.

1.3 Multimedia System: Components

- Now let us consider the Components (Hardware and Software) required for a multimedia system:
  - **Capture devices —** Video Camera, Video Recorder, Audio Microphone, Keyboards, mice, graphics tablets, 3D input devices, tactile sensors, VR devices. Digitizing Hardware
  - **Storage Devices —** Hard disks, CD-ROMs, DVD-ROM, etc
  - **Communication Networks —** Local Networks, Intranets, Internet, Multimedia or other special high speed networks.
  - **Computer Systems —** Multimedia Desktop machines, Workstations, MPEG/VIDEO/DSP Hardware
  - **Display Devices —** CD-quality speakers, HDTV,SVGA, Hi Resolution monitors, Color printers etc.

1.4 Typical software system

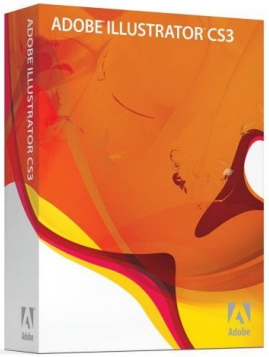
- **Music Sequencing and Notation**
- **Digital Audio**
- **Graphics and Image Editing**
- **Video Editing**
- **Animation**
- **Multimedia Authoring**

1.4 Software: Music Sequencing and Notation

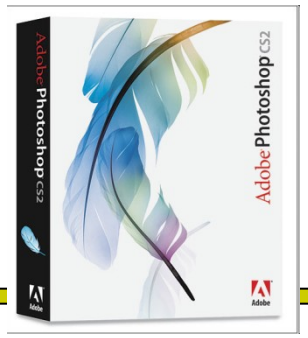
- Cakewalk，well-known older name for Pro Audio
  - Sequencing and editing MIDI music

1.4 Software: Graphics and Image Editing

- **Adobe Illustrator**, powerful publishing tool for creating and editing vector graphics



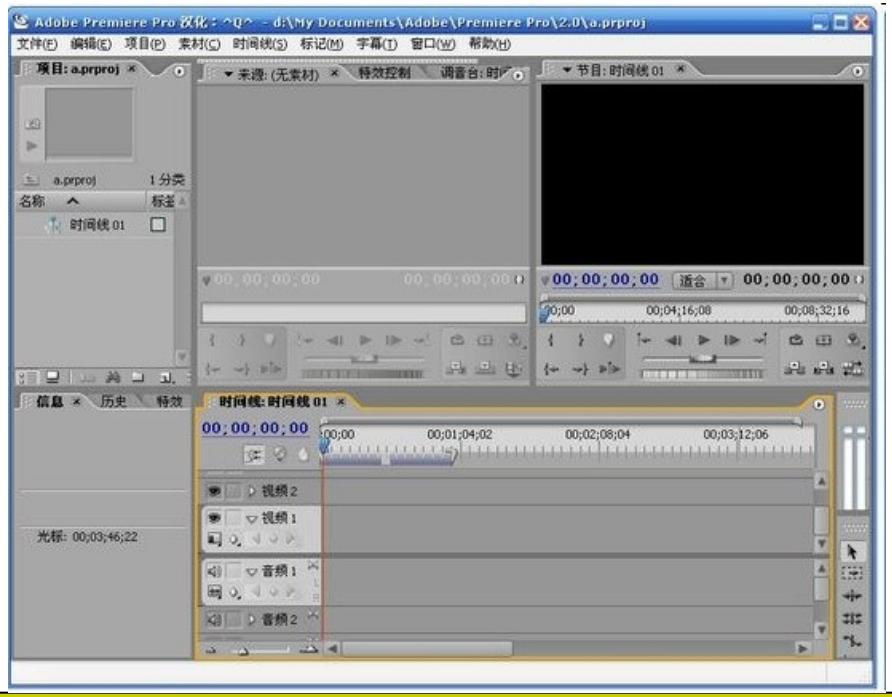
- **Adobe Photoshop**, the standard tool for graphics, image processing, and image manipulation
  - Layers of images, graphics, and text, for maximum flexibility;



1.4 Software：Video Editing

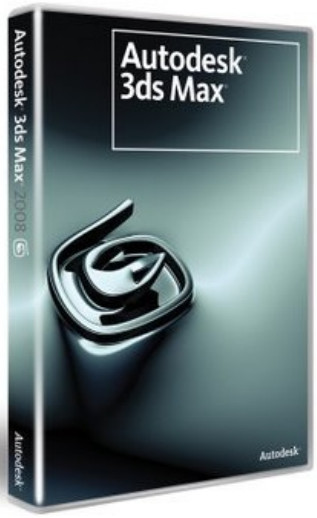
Adobe Premiere

- A simple, intuitive video editing tool for nonlinear editing – putting video clips into any order



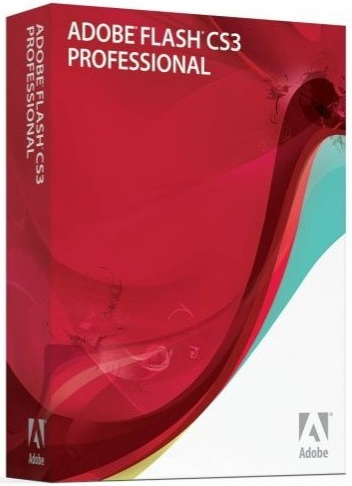
1.4 Software: Animation

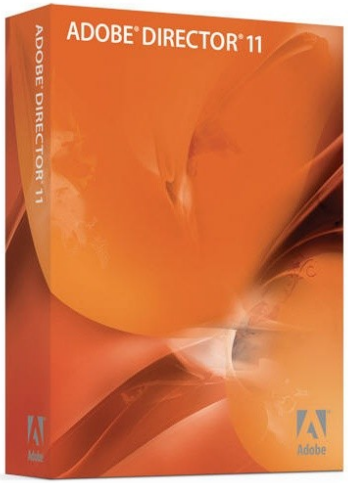
- **Multimedia API**
  - Java3D
  - DirectX
  - OpenGL
- **Rendering Too**
  - 3D Studio Max
  - Maya

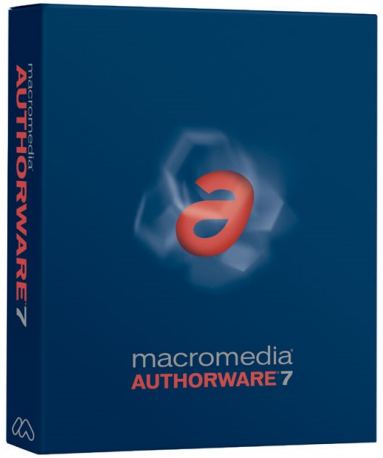


1.4 Software: Multimedia Editor

- Adobe Flash
- Adobe Director
- Authorware







1.5 Content of this Course

- **Graphics and Image Data Representations, Color in Image and Video**
  - **Graphic/Image Data Types**
  - **Popular File Formats**
  - **Color Science**
  - **Color Models in Images/Videos**
- **Basics of Video and Audio**
  - **Types of Video Signals**
  - **Analog and Digital Video**
  - **Digitization of Sound**
  - **Quantization and Transmission of Audio**

1.5 Content of this Course

- **Multimedia Data Compression**
  - **Lossless Compression Algorithms: Basics of Information Theory; Run-length Coding; Variable-Length Coding; Dictionary-Based Coding; Arithmetic Coding; Lossless Image Compression;**
  - **Lossy Compression Algorithms: Distortion Measures; The Rate-Distortion Theory; Quantization; Transform Coding; Wavelet-Based Coding;**
  - **Image Compression Standards: Main Steps in JPEG Image Compression; JPEG Modes; JPEG2000 & JPEG-LS; Standard;**
  - **Video Compression Techniques: Video Compression Based on Motion Compression; Search for Motion Vectors; Intra-Frame Coding; Inter-Frame Predictive Coding;**
  - **Audio Compression Techniques: ADPCM in Speech Coding; Vocoders**

1.5 Content of this Course

- **Multimedia Coding Standards**
  - **MPEG-1：** Motion Compensation, Differences from H.261, Video Bitstream
  - **MPEG-2：** Interlaced Video, Scalabilities, Differences from MPEG-1
  - **MPEG-4：** Object-Based Coding, Synthetic Object Coding, Object types, Profiles and levels
  - **MPEG-4 Part10 & H.264：** Core Features, Baseline Profile Features, Main Profile Features, Extended Profile Features

1.5 Content of this Course

- **Multimedia Communication**
  - **Quality of Multimedia Data Transmission**：**QoS, QoS for IP, Prioritized Delivery**
  - **Multimedia over IP**：**IP-Multicast, RTP, RSVP, RTSP**
  - **Streaming**：**MPEG-4 over IP、Media-on Demand**
  - **Multimedia over Wireless Networks**：**Synchronization Loss, Error Resilient Entropy Coding, Error Concealment**

1.5 Content of this course

- **Multimedia Retrieval**
  - **Case Study： Color Histogram, Color Density, Color Layout, Texture Layout, Search by Illumination Invariance**
  - **Synopsis of Current Image Search System： QBIC**
  - **Relevance Feedback**
- **Multimedia application system and technical research**
  - **Typical application： network streaming media and IPTV、virtual reality system**
  - **Technical research： multimedia security and copyright, content cognition, trans-code, high-quality reliable transmission**

Network & Media Laboratory

The End

Thanks !

Email: ldm@zju.edu.cn