Multimedia Introduction

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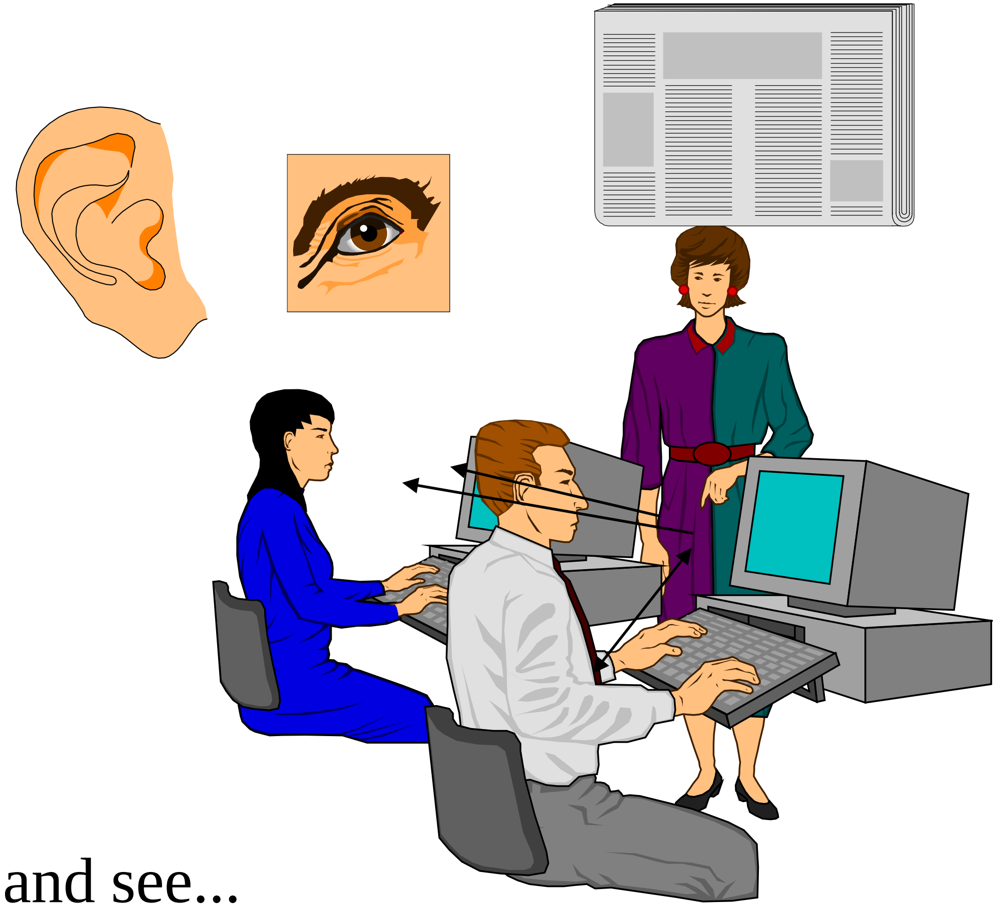
Content

- What is Multimedia?
- Multimedia and computer science
- Forms of communication in Multimedia
- Multimedia Research: Topics & Projects
- Multimedia Projects
- Multimedia Life Cycle
- Multimedia Desirable Features
- Components of a Multimedia System
- Virtual Reality as Extension of Multimedia

Why use multimedia?



- It is **said** that we retain:

  20% of all we hear

  30% of all we see

  40% of all we read..

..but 80% of all we read, hear and see...

Multimedia from different point of views

When different people mention the term multimedia, they often have quite different, or even opposing, viewpoints.

A PC vendor: a PC that has sound capability, a DVD-ROM drive, and perhaps the superiority of multimedia-enabled microprocessors that understand additional multimedia instructions.

A consumer entertainment vendor: interactive cable TV with hundreds of digital channels available, or a cable TV-like service delivered over a high-speed Internet connection.

A Computer Science (CS) student: applications that use multiple modalities (methods), including text, images, drawings (graphics), animation, video, sound including speech, and interactivity.

Multimedia and Computer Science

In computer science, multimedia is in the intersection among different areas such as:

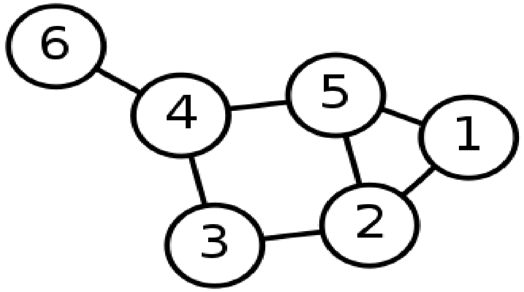
- Graphics
- Human Computer Interaction (HCI)
- Visualization
- Computer vision
- Data compression
- Graph theory
- Networking
- Database systems
- Multimedia and Hypermedia

Definitions

- ***Human–computer interaction (HCI)*** is the study, planning and design of the interaction between people (users) and computers. It is often regarded as the intersection of computer science, behavioral sciences, design and several other fields of study. Interaction between users and computers occurs at the user interface (or simply interface), which includes both software and hardware.
- ***Visualization***: is the process of presenting data in a form that allows rapid understanding of relationships and findings that are not readily evident from raw data (using any technique for creating images, diagrams, or animations).
- ***Computer vision*** (or machine vision) is the science and technology of machines that see. Here see means the machine is able to extract information from an image, to solve some task, or perhaps "understand" the scene in either a broad or limited sense.

Definitions (ctd)

- **Graph Theory** is the study of *graphs*, mathematical structures used to model pairwise relations between objects from a certain collection. A "graph" in this context refers to a collection of vertices or 'nodes' and a collection of *edges* that connect pairs of vertices.



- **Hypermedia** is a computer based information retrieval system that enables a user to gain or provide access to texts, audio and video recordings, photographs and computer graphics related to a particular subjects. Hypermedia is a term created by Ted Nelson. Hypermedia is used as a logical extension of the term hypertext in which graphics, audio, video, plain text and hyperlinks intertwine (متشابك)to create a generally non-linear medium of information. This contrasts with the broader term multimedia, which may be used to describe non-interactive linear presentations as well as **Hypermedia**.

Forms of Communication in Multimedia

Multimedia involves different medias, these are:

- Text
- Audio
- Images
- Drawings
- Animation
- Video

Applications of Multimedia

Examples of how these modalities are put to use:

1. Video teleconferencing.
2. Distributed lectures for higher education.
3. Tele-medicine (is a rapidly developing application of clinical medicine, where medical information is transferred through interactive audiovisual media for the purpose of consulting. Telemedicine can also be used to conduct examinations and remote medical procedures)
4. Co-operative work environments.
5. Searching in (very) large video and image databases for

   target visual objects.

Application of Multimedia (ctd)

6. Augmented reality(الحقيقة المدمجة) : placing real-appearing computer graphics and video objects into scenes.
   - A possible display technique for Augmented Reality is head–mounted displays.
7. Making multimedia components editable. allow the user side to decide what components, video, graphics, etc., are actually viewed; allow the client to move components around or delete them. Making components distributed.
8. Building “inverse-Hollywood” applications that can recreate the process by which a video was made. This then allows storyboard pruning.
9. Using voice-recognition to build an interactive environment, say a kitchen-wall web browser.

Multimedia Research: Topics & Projects

To the computer science researcher, multimedia consists of a wide variety of topics:

- **Multimedia processing and coding**
  - ✓ Multimedia content analysis
  - ✓ content-based multimedia retrieval
  - ✓ multimedia security
  - ✓ audio/image/video processing
  - ✓ compression, etc.
- **Multimedia system support and networking**
  - ✓ Network protocols
  - ✓ Internet
  - ✓ Operating systems
  - ✓ Servers and clients
  - ✓ Quality of service (QoS)
  - ✓ Databases.

Multimedia Research: Topics & Projects (ctd)

- **Multimedia tools end-systems applications**
  - ✓ Hypermedia systems
  - ✓ User interfaces
  - ✓ Authoring systems
- **Multi-modal interaction and integration**
  - ✓ Ubiquity— web-everywhere devices
  - ✓ Multimedia education including Computer Supported Collaborative Learning
  - ✓ Design and applications of virtual environments

Multimedia Projects

Many exciting research projects are currently underway. Here are a few of them:

Camera-based object tracking technology:

tracking of the control objects provides user control of the process.

3D motion capture:

used for multiple actor capture so that multiple actors in a virtual studio can be used real to automatically produce realistic animated models with natural movement.

Multiple views:

allowing photo-realistic (video-quality) synthesis (mixture) of virtual actors from several cameras or from a single camera under differing lighting.

3D capture technology:

allow synthesis of highly realistic speech facial animation from speech.

Multimedia Projects (ctd)

Specific multimedia applications:

aimed at handicapped (معوقين) persons with low vision capability and the elderly —a rich field of endeavor (attempt).

Digital fashion:

aims to develop smart clothing that can communicate with other such enhanced clothing using wireless communication, so as to artificially enhance human interaction in a social setting.

Electronic House-call system:

an initiative for providing interactive health monitoring services to patients in their homes

Augmented Interaction applications:

used to develop interfaces between real and virtual humans for tasks such as augmented storytelling .

Multimedia Introduction-part2

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Content

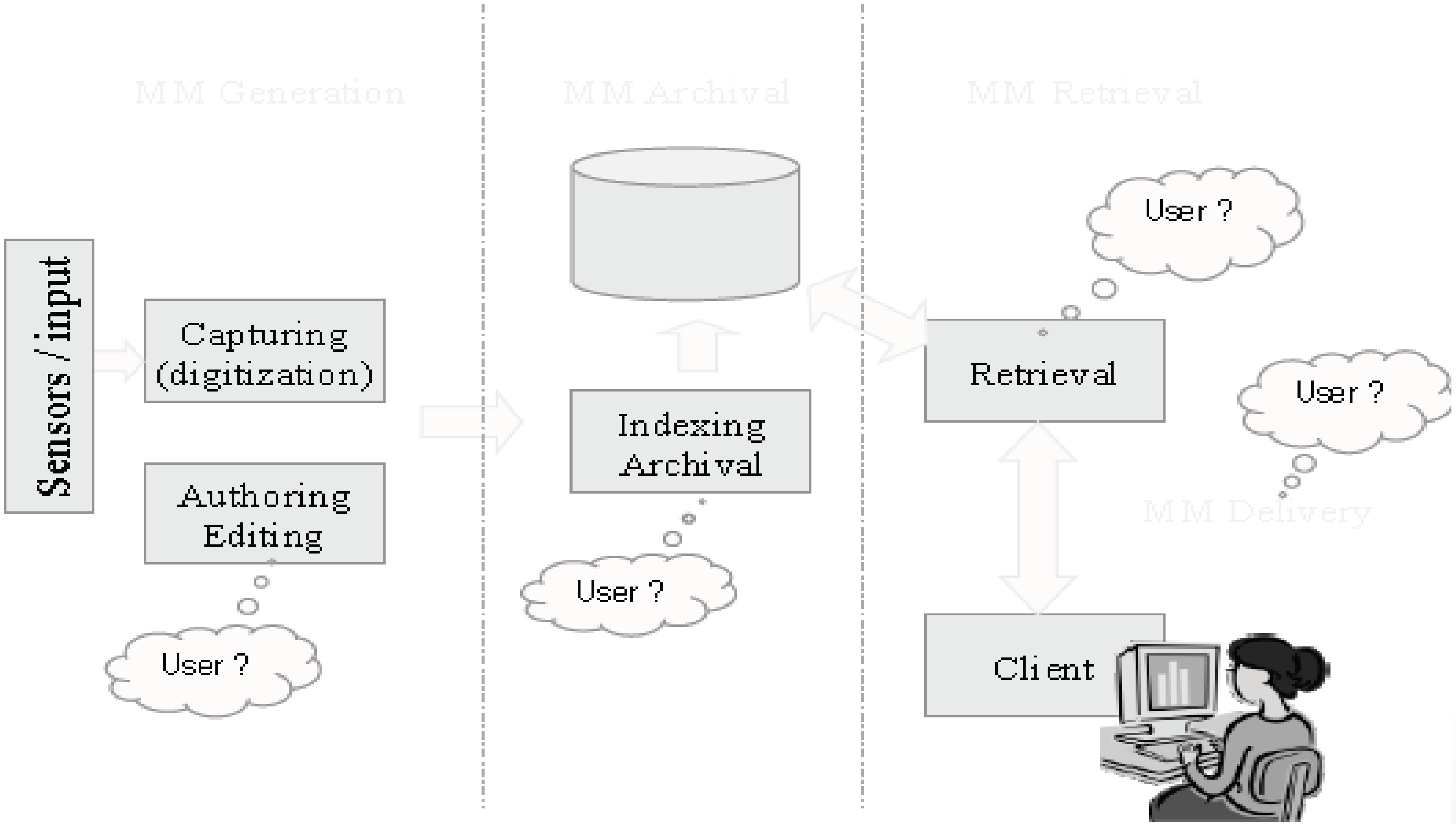
- Multimedia Life Cycle
- Multimedia Desirable Features
- Components of a Multimedia System
- Virtual Reality as Extension of Multimedia

Multimedia Life Cycle

Four main phases in multimedia life cycle

- Multimedia Generation, Authoring, Capturing…
- Multimedia Representation, and processing (ex: indexing)
- Multimedia Retrieval: answering user queries.
- Multimedia Delivery

Multimedia life cycle



Li & Drew

Multimedia System Desirable Features

- Very High Processing Power
- Special Hardware/Software needed (e.g. GPUs)
- Efficient I/O
- Large Storage and Memory
- High Speed Network Support

Components of a Multimedia System

- Capture Devices
  - ✓ e.g. Video Camera, Microphone, Digitizing/Sampling Hardware, etc.
- Storage Devices
  - ✓ e.g. Hard disks, CD-ROMs, DVD, Blu-ray, etc
- Communication Networks
  - ✓ Internet, wireless internet, etc.
- Computer Systems:
  - ✓ e.g. Multimedia Desktop machines, Workstations, smart phones, iPads
- Rendering(تقديم)Devices
  - ✓ e.g. CD-quality speakers, HDTV, Hi-Res monitors, Color printers etc.

Rendering

Rendering: is the process of generating an image from a model (or models in what collectively could be called a *scene* file), by means of computer programs.

A scene file contains objects in a strictly defined language or data structure. It would contain geometry, viewpoint, texture, lighting, and shading information as a description of the virtual scene.

The data contained in the scene file is then passed to a rendering program to be processed and output to a digital image or raster graphics image file.

Rendering Tools

- ***3D Studio Max***: rendering tool that includes a number of very high-end professional tools for character animation, game development, and visual effects production.
- ***Softimage XSI***: a powerful modeling, animation, and rendering package used for animation and special effects in films and games.
- ***Maya***: competing product to Softimage (boasts an impressive visual effects and game development toolset) ; as well, it is a complete modeling package. Maya is the industry leading package for 3D animation.
- ***RenderMan***: rendering package, created by Pixar, is both a software and an application programming interface (API) for network distributed rendering of complex and potentially ray-traced three dimensional views, employing a render farm of many client computers. The clients do not require 3D graphics cards, but may benefit from them if they are available.

Virtual Reality as Extension of Multimedia

- Virtual reality is an extension of multimedia.
- It uses the basic multimedia elements of imagery, sound, and animation.
- It requires terrific computing horsepower to be realistic
- In VR, cyberspace is made up of thousands of geometric objects plotted in three-dimensional space.
- The standards for transmitting VR in Virtual Reality Modeling Language (VRML) documents have been developed on the World Wide Web.
- VRML documents have the file extension .wrl.

Multimedia Projects

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Content

- Concepts in Multimedia
- Multimedia Project
- Stages of Multimedia Project
- Requirements for a Multimedia Project
  Members of a Multimedia Team project
- Roles and Responsibilities in a Multimedia Team project

Definitions

- Multimedia is a combination of text, art, sound, animation, and video.
- It is delivered to the user by electronic or digitally manipulated means.
- Multimedia becomes interactive multimedia when a user is given the option of controlling the elements.
- Interactive multimedia is called hypermedia when a user is provided a structure of linked elements for navigation.
- The software vehicle, the messages, and the content together constitute a multimedia project.
- A multimedia project shipped to end-users with or without instructions is called a multimedia title.
- A project can also be launched on the Web.

Multimedia Projects

- Multimedia projects can be linear or nonlinear.
  - Projects that are not interactive are called linear.
  - Projects where users are given navigational control are called non-linear and user-interactive.
- A multimedia project development requires creative, technical, organizational, and business skills.
- Authoring tools are used to merge multimedia elements into a project. These software tools are designed to manage individual multimedia elements and provide user interaction.

The primary media for delivering multimedia projects are:

- Compact disc read-only (CD-ROM).
- Digital Versatile Disc (DVD).
- Copper wire, glass fiber, and radio/cellular technologies also serve a means for delivering multimedia files across a network.

Stages of Multimedia Project

- The needs of a project are analyzed by outlining its messages and objectives.
- The basic stages of a multimedia project are
  - Planning and costing
  - Design and production
  - Testing and delivery.

Stages of Multimedia Project (ctd)

- ***Planning and costing***
  - A **plan** that outlines the required multimedia expertise is prepared.
  - Develop a creative "**look and feel**" **(**what a user sees on a screen and how he or she interacts with it), as well as a structure and a navigational system that will allow the viewer to visit the messages and content.
  - A time estimate and a budget are prepared.
  - A short prototype or proof-of-concept is prepared.

    prototype is a simple, working example to demonstrate whether or not your idea is feasible.

Stages of Multimedia Project (ctd)

Design and production:

- The planned tasks are performed to create a finished product.
- The product is revised, based on the continuous feedback received from the client.

Testing and Delivery

- Testing - The program is tested to ensure that it meets the objectives of the project, works on the proposed delivery platforms, and meets the client requirements.
- Delivery - The final project is packaged and delivered to the end user.

Requirements for a Multimedia Project

- ***Hardware***
- ***Software***
- ***Creativity and organizational skills***

Hardware

- The most significant platforms for producing and delivering multimedia projects are Macintosh operating system and Microsoft Windows.

- Hardware needed for Multimedia projects are:

  - ✓ All contemporary personal computers (provide an easy-to-use graphical user interface (GUI)) are quite capable of displaying Multimedia content (Even cell phones)
  - ✓ For *authoring content, a bigger and faster machine is* needed
  - ✓ *Bandwidth is still and always will be an issue*

Software

- Multimedia software provides specific instructions to the hardware for performing tasks.
- Software tools are divided into
  - production tools
  - authoring tools.

Creativity and organizational skills

- In a multimedia project, being creative implies knowledge of hardware and software.
- It is essential to develop an organized outline detailing the skills, time, budget, tools and resources needed for the project.
- Assets such as graphics, sound and video should be continuously monitored throughout the project's execution.
- A standardized file-naming procedure should be followed for precise organization and swift retrieval.

Members of a Multimedia Team

- A team of skilled individuals is required to create a good multimedia project.
- Team building refers to activities that help a group and its members function at optimum levels.
- The diverse range of skills required for a project is called the multimedia skillset.

A multimedia team consists of the following:

- Project manager.
- Multimedia designer.
- Interface designer.
- Writer.
- Video specialist.
- Audio specialist.
- Multimedia programmer (software engineer).
- Producer for the Web.
- Computer programmers.

Roles and Responsibilities in a Multimedia Team

The ***project manager*** is responsible for:

- The overall development, implementation, and day-to-day operations of the project.
- The design and management of a project.
- Understanding the strengths and limitations of hardware and software.
- Ensuring people skills and organizational skills.
- Conveying information between the team and the client.

Multimedia designer - This team consists of:

- *Graphics designers*, *animators*, and *image processing specialists* who deal with visuals, thereby making the project appealing (attractive) and aesthetic (الجمالي).
- *Instructional designers*, are specialist in education or training and make sure that the subject matter is presented clearly for the target audience.

Roles and Responsibilities in a Multimedia Team (ctd)

Multimedia designer - This team consists of (continued):

- Interface designers, who devise the navigational pathways and content maps (see the flash presentation with the slides).
- Information designers, who structure content, determine user pathways and feedback, and select presentation media.

An interface designer is responsible for:

- Creating a software device that organizes content, allows users to access or modify content, and presents that content on the screen.
- Building a user-friendly interface.

A multimedia writer is responsible for:

- Creating characters, actions, point of view, and interactivity.
- Writing proposals and test screens.
- Scripting voice-overs (also known as **off-camera** or **off-stage commentary(التعلِيق)**) and actors' narrations (روايات الممثلين).

Roles and Responsibilities in a Multimedia Team (ctd)

***A video specialist needs to understand*:**

- The delivery of video files on CD, DVD, or the Web.
- How to shoot quality video.
- How to transfer the video footage to a computer.
- How to edit the footage down to a final product using digital nonlinear editing system (NLE).

***An audio specialist is responsible for*:**

- Locating and selecting suitable music talent.
- Scheduling recording sessions.
- Digitizing and editing recorded material into computer files.

Roles and Responsibilities in a Multimedia Team (ctd)

Multimedia programmer, also called a software engineer:

- Integrates all the multimedia elements into a seamless (continuous) project, using authoring systems or programming language.
- Writes codes for the display of multimedia elements, and to control various peripheral devices.
- Manages timings, transitions, and record keeping.

Multimedia producer for the Web:

- Web site producers put together a coordinated set of pages for the Web.
- They also co-ordinate updates and changes.

Summary

- The diverse skills required to create a multimedia project is called the multimedia skillset.
- Team building refers to activities that help a group and its members function at optimum levels of performance.
- Roles and responsibilities are assigned to each team member in a multimedia project.

Multimedia
Text

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Content

- Multimedia Data: Text
- Using Text in Multimedia: Type Terminology
- Font Cases &Case Sensitive
- Using Text Elements in a Multimedia Presentation
- Fonts and Characters
- Font Editing and Design Tools
- Multimedia and Hypertext
- Searching for Words

Multimedia Data: Text

- **Input**: keyboard, touch pad
- Stored and input character by character.
- Storage of text is 1 or 2 bytes per character.
- Other forms of data (e.g. Spreadsheet files, XML) may store format as text (with formatting).
- Size Not significant compared with other multimedia data.

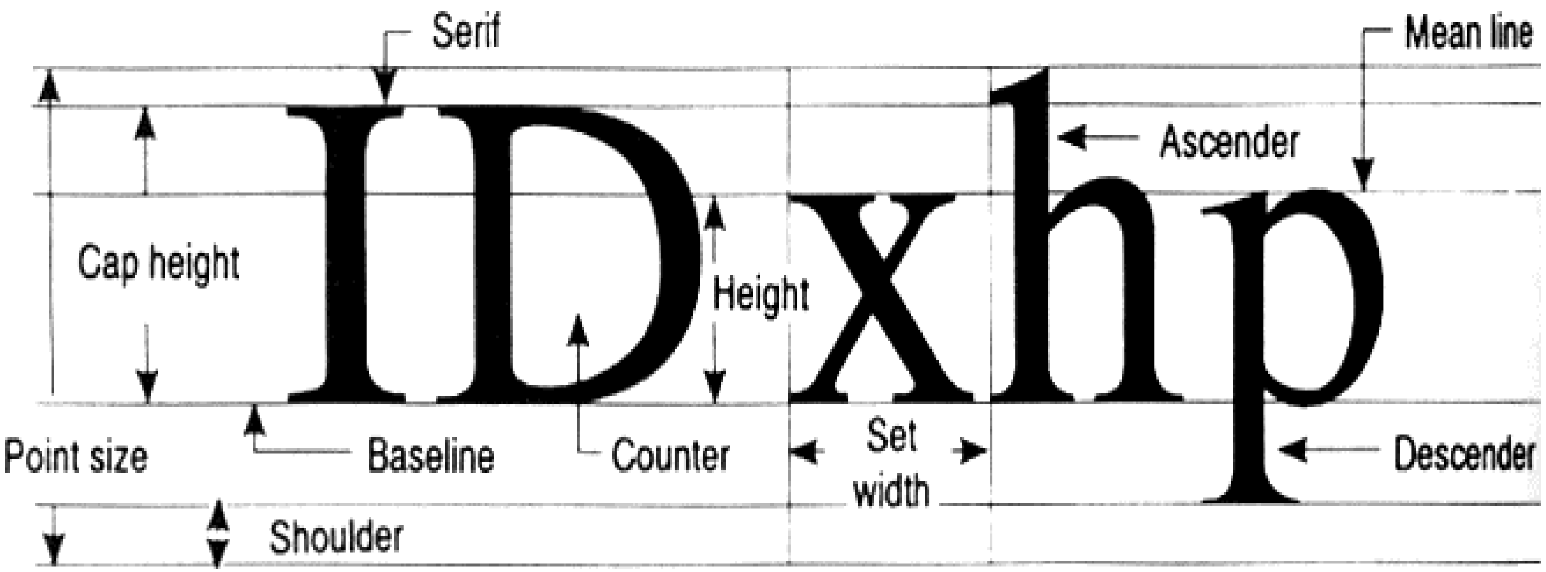
Using Text in Multimedia: Type Terminology

Font is a particular size, weight and style of a typeface

- The font ***weight*** is the thickness of the character outlines relative to their height
- ***Typeface*** (Arial, Courier, Times, etc.)
- ***Styles*** (bold, italic, regular underline)
- ***Font sizes*** are in points 1 point = 1/72 inch X-height is the height of the lower case letter x
- ***Points:*** the smallest unit of measure in typography. It is used to measure font size, leading.
- ***Leading (line-spacing)***: refers to the distance between the baselines of successive lines.

Kerning

Character Metrics



Ascender: الصاعد

Descender: السليل (النازل)

Serif: الرقيق

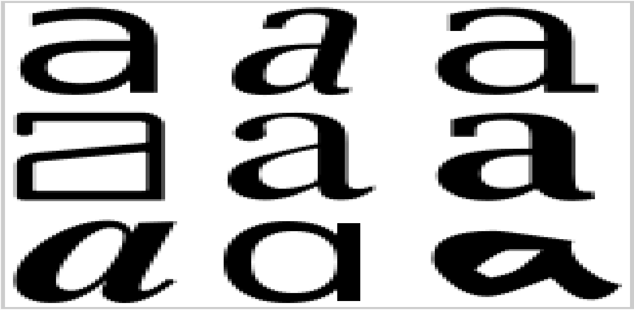
Serif and Sans Serif

- Font type either has a little decoration at the end of the letter - called a serif
- or it doesn't - sans serif ("sans" from the French meaning without)
- Examples (Times - serif "T")

  (Arial - sans serif "T")
- Use what is appropriate to convey your message

Fonts and Faces

- Bitmapped fonts cannot be altered.
  - A bitmap font is one that stores each glyph (رسومي) as an array of pixels (that is, a bitmap).
  - A glyph: is an element of writing: an individual mark on a written medium that contributes to the meaning of what is written.



Various glyphs representing the lower case letter "a".

- The computer draws a letter on the screen with pixels or dots.

Font Cases &Case Sensitive

- uppercase and lowercase
- A capitalized letter is referred to as 'uppercase', while a small letter is referred to as 'lowercase.'
- Placing an uppercase letter in the middle of a word is referred to as intercap.

- Password, and paths in a URL are case sensitive (that is “home” is different from “HOME”)
- It is easier to read words that have a mixture of upper and lower case letters rather than all upper case

Text Font Design Tips

- Use the most legible font available
- Use as few different faces as possible .
- Use **bold** and *italics* to convey meaning
- Adjust line spacing (leading)
- Adjust the spacing between letters in headings.
- Use colors and background to make type stand out.
- Use meaningful word for links and menus
- Experiment with shadows
- Surround headlines with white space

Using Text Elements in a Multimedia Presentation

The text elements used in multimedia are:

- Menus for navigation.
- Interactive buttons.
- Fields for reading.
- HTML documents.
- Symbols and icons.

Buttons for Interaction

- Buttons are objects that make things happen when they are clicked
- Use common button shapes and sizes
- Label them clearly
- BE SURE THEY WORK!

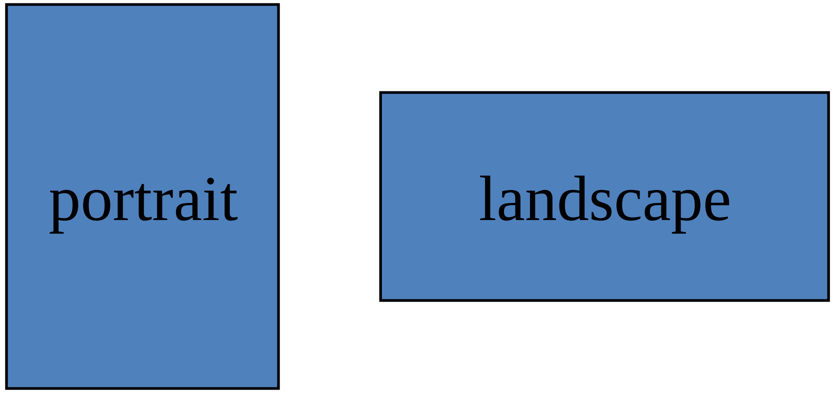
Fields for Reading

- Reading from a computer screen is slower than from a book
- People blink 3-5 times/minute, using a computer and 20-25 times/minute reading a book
- This reduced eye movement causes fatigue (إجهاد), dryness
- Try to present only a few paragraphs

  per page

Portrait vs. Landscape

- Monitor use wider-than-tall aspect ratios called landscape
- Most books use taller-than- wide orientation, called portrait
- Don’t try to shrink a full page (it will be portrait) onto a monitor (it will be Landscape).



Fonts and Characters

- Fonts smaller than 12 point are not very legible on a monitor
- Never assume the fonts installed on your computer are on all computers
- Stay with TrueType fonts ordinarily
- The American Standard Code for Information Interchange (ASCII) character set - most common. ASCII is a 7-bit coding system (ca code 2^7=128 different character).
- Then ASCII code is extended to 8 bit code/character (could code 2^8=256 different character)
- Extended Character set - used for HTML
- UNICODE –supports characters for all known languages

Unicode

- Unicode is a 16-bit architecture for multilingual text and character encoding.
- Developed in 1989 for multilingual text
- Contains 65,000 (2^{16})characters form all known languages
- Where several languages share a set of symbols, they are grouped into a collection called scripts (e.g. Latin, Arabic, Cyrillic, Greek, Tibetan, etc.)
- Shared symbols are unified into collections called scripts
    - Numbers
    - Mathematical symbols
    - Punctuation
    - Arrows, blocks and drawing shapes
    - Technical symbols

HTML Documents

- Standard document format on the web is called Hypertext Markup Language (HTML)
- Originally designed for text not multimedia - now being redesigned as Dynamic HTML (DHTML)
  - DHTML, is an umbrella term for a collection of technologies used together to create interactive and animated web sites.
- Specify typefaces, sizes colors and properties by “marking up” the text with tags (such as <B>, </B>)

HTML Documents

- The Font tag is used to specify the font to be displayed (if present)

  <font face = “Verdana, Arial, Times”>
- If those fonts are not on the system, the default is used.

Symbols and Icons

- Symbols act like “visual words” to convey meaning, (called icons)
- Icons and sound are more easily remembered than words
- It is useful to label icons for clarity

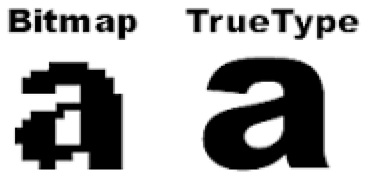
Animating Text

- To grab a viewer's attention:
  - let text "fly" onto screen
  - rotate or spin text, etc.

The Font Wars

- PostScript is a method of describing an image in terms of mathematical constructs. It is a programming language that describes the appearance of a printed page.
- PostScript characters are scalable and can be drawn much faster.
- The two types of PostScript fonts are Type 3 and Type 1.

- TrueType
- Apple and Microsoft developed the TrueType methodology.
- TrueType fonts offer the highest possible quality on computer screens and printers



Character Sets

- Viewing a presentation on either MAC and PC reveals differences
- Some contain different symbols, Others represent an entire concept with a single symbol (as in some Asian languages)

Mapping across platforms:

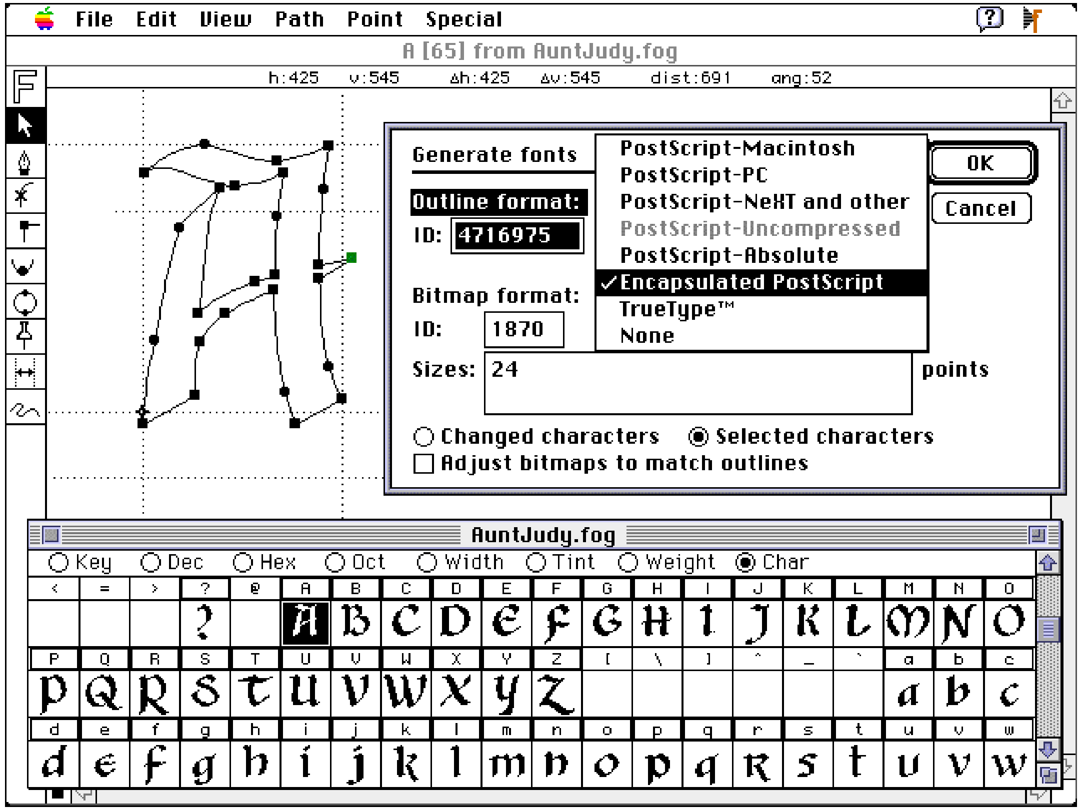
  - Fonts and characters are not cross-platform compatible.
  - They must be mapped to the other machine using font substitution.
- Translating into another language is called <u>localization</u>
- If same font doesn’t exist on the other machine, one is substituted (called <u>font substitution</u>)
- To avoid this, convert to bitmaps

Font Editing and Design Tools

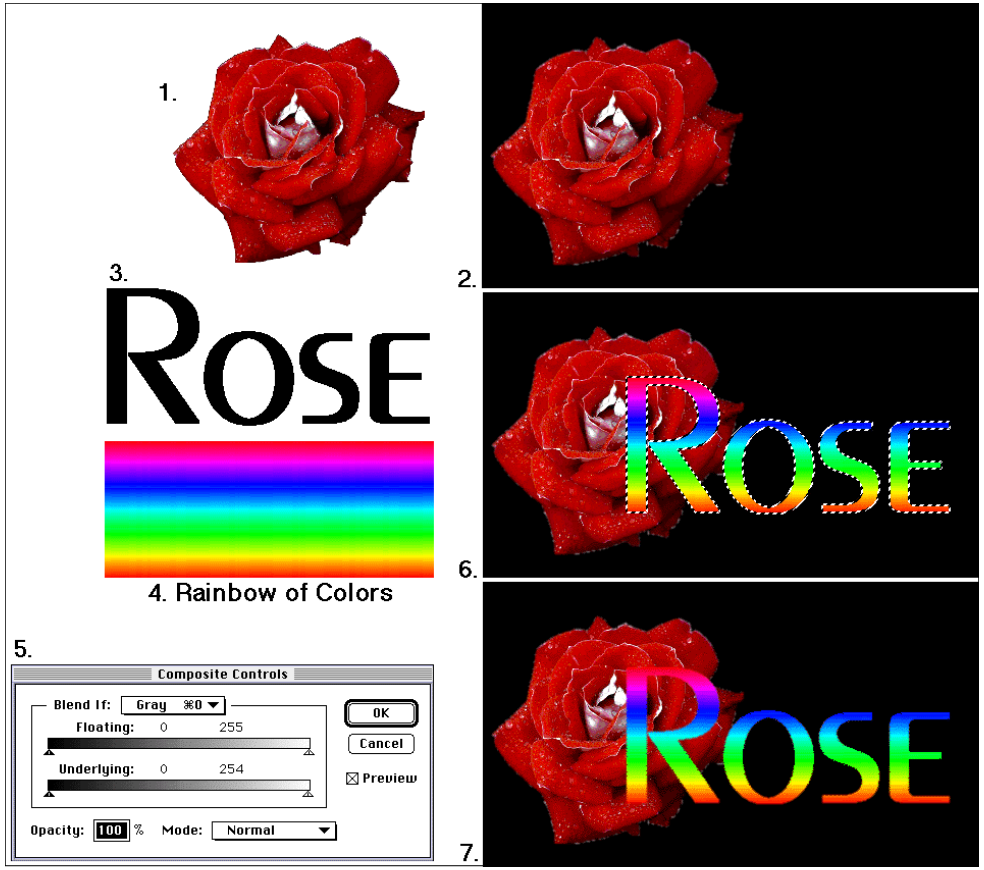
- Allow you to create your own fonts
  - ResEdit for MAC
  - Fontographer (from Macromedia) can be used to create Postscript, TrueType and bitmapped fonts for MAC, SUN includes a freehand drawing tool.
    - It is compatible with both Macintosh and Windows platform.
  - 3D programs, such as COOL 3D and HotTEXT, create special effects.

Font Editing and Design Tools

- Fontographer (from Macromedia)



Editing and Design Tools



Creating Attractive Texts

Applications that are used to enhance texts and images include:

- Adobe Photoshop
- TypeStyler
- COOL 3D
- HotTEXT
- TypeCaster

Multimedia and Hypertext

- Multimedia (combines text, graphics and audio)
- Multimedia - Interactive multimedia - gives user control over what and when content is viewed (non-linear)
- Hypertext system is text which contains links to other texts
- Hypertext tools (Building or authoring tools)
  - builder creates links, identifies nodes, generates an index of words
- Reading
  - both linear and increasingly non-linear
- Using hypertext systems.
- Searching for words.
- Hypermedia -provides a structure of linked elements through which user navigates and interacts
- Hypermedia structures.

Hypermedia Structures

- Link - connections between conceptual elements (navigation pathways and menus)
- Node - contains text, graphics sounds
- Anchor - the reference from one document to another document, image, sound or file on the web
- Link anchor - where you came from

Searching for Words

Typical methods for word searching in hypermedia systems are:

- Categorical search
- Word relationship
- Alternates
- truncation (اقتطاع)- using only part of word, such as geo might yield result with geology, geography, George, etc.
- boolean search using AND, OR, NOT
- Frequency

- Search engines employ “robots” to visit web pages and create indexes.

Multimedia
Image

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Content

- Multimedia Data: Image
  - Creation of multimedia images.
  - Creation of still images.
  - Colors and palettes (لوحات) in multimedia.
  - Image file types used in multimedia.

Creation of Still Images

- Still images may be the most important element of a multimedia project.
- The type of still images created depends on the display resolution, and hardware and software capabilities.
- Types of still images.
- 3-D drawing and rendering.

Types of Still Images

Still images are generated in two ways:

- Bitmaps.
- Vector-drawn graphics.

Bitmaps

- Bitmap is derived from the words ‘bit’, which means the simplest element in which only two digits are used, and ‘map’, which is a two-dimensional matrix of these bits.
- A bitmap is a data matrix describing the individual dots of an image.

Bitmaps are an image format suited for creation of:

  - Photo-realistic images.
  - Complex drawings.
  - Images that require fine detail.

- A bitmap is made up of individual dots or picture elements known as pixels or pels.
- Bitmapped images can have varying bit and color depths.

Bitmaps

Bit Depth	Number of Colors Possible	Available Binary Combinations for Describing a Color
1-bit	2	0, 1
2-bit	4	00, 01, 10, 11
4-bit	16	0000, 0001, 0011, 0111, 1111, 0010, 0100, 1000, 0110, 1100, 1010, 0101, 1110, 1101, 1001, 1011

Available binary Combinations for Describing a Color

Number of colors=$2^{\text{Bit Depth}}$

EX: for bit depth=8,

color doth is Max. # of colors within the image

$\therefore$ color depth= 256 (from 0 to 255)

Bitmap Image

Palette Image

File consists of
:
1. Header (**54 byte**) used to store file type, size, etc.
2. **palette** (table contains set of entries.
Each entry (4 bytes) represent color (RGB+reserve)
palette size= No. of colors* 4
3. data part (2d matrix of pixels)
pixel size (bit depth)/ 8 (to find × W ×H size in bytes)

True color Image

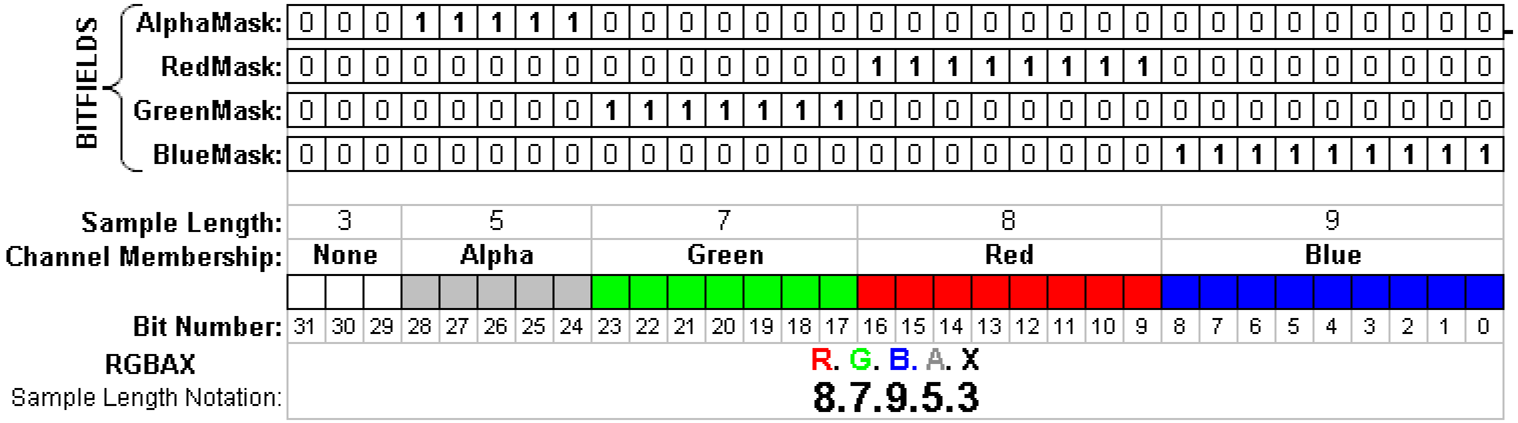
File Consists of:
1-Header (**54 byte**) used to store file type, size, etc.
2-data part (2d matrix of pixels)
pixel size (bit depth)/ × W ×H
8
In True color image, bit depth either 24 or 32 bits

Bitmap Images

- Still pictures which (uncompressed) are represented as a bitmap (a grid of pixels).
- Input: Digital camera, scanner or generated by graphics editor programs (e.g. Paint)
- Analog sources will require digitizing.
- Stored at
  - 1 bit per pixel (Black and White),
  - 4,16, 8 Bits per pixel (Grey Scale, Color Map)
  - or 24 Bits per pixel (True Color)
- Storage increases with image size
- Compression is commonly applied

Image size: palette Image

- Size: a 512×512 8-bit Grey scale image takes up ≅1/4 Mb, with no compression.
- Image size =H × W+ header (54 byte)+ palette size
- The colors in the palette (color table) are usually specified
  - in the 4-byte per entry [RGBA32]() format (RGB +reserved).



- palette size= colors in the palette ×number of colors
- Ex: find the size of 4 bit 256 ×256 image.
- Image size (in bytes)=256*256+54+2^4*4=65654 B (≅64KB).

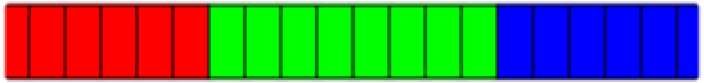
Image size: True color Images

- In a color 24-bit image, each pixel is represented by three bytes, usually representing RGB.
- This format supports 256 × 256 × 256 possible combined colors, or a total of 16,777,216 possible colors.
- However such flexibility does result in a storage penalty: A 640 × 480 24-bit color image would require 921.6 kB of storage without any compression.
- An important point: many 24-bit color images are actually stored as 32-bit images, with the extra byte of data for each pixel used to store an alpha value representing special effect information (e.g., transparency).

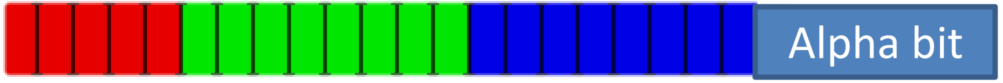
Image size: True color Images (Cont.)

- Image size =H × W+ header (54 byte)
  - Ex: find the size of True color 10 ×10 image.
  - Image size (in bytes)=10*10*3+54= B (≅64KB).

- 24 bit image, each pixel is 3 bytes.



- 32 bit, each pixel is 4 bytes



Bitmaps Insertion

- Bitmaps can be inserted by:
  - Using clip art galleries.
  - Using bitmap software.
  - Capturing and editing images.
  - Scanning images.

Using Clip Art Galleries

- A clip art gallery is an assortment of graphics, photographs, sound, and video.
- Clip arts are a popular alternative for users who do not want to create their own images.
- Clip arts are available on CD-ROMs and on the Internet.

Using Bitmap Software

The industry standard for bitmap painting and editing programs are:

- Adobe's Photoshop and Illustrator.
- Macromedia's Fireworks.
- Corel's Painter.
- CorelDraw.
- Quark Express.

Capturing, Scanning and Editing Images

- Capturing and storing images directly from the screen is another way to assemble images for multimedia.
- The PRINT SCREEN button in Windows and COMMAND-CONTROL-SHIFT-4 keystroke on the Macintosh copies the screen image to the clipboard.
- Users can scan images from conventional sources and make necessary alterations and manipulations.

Capturing and Editing Images

Image editing programs enable the user to:

- Enhance and make composite images.
- Alter and distort (تشوه) images.
- Add and delete elements.
- Morph (manipulate still images to create animated transformations).

Vector-Drawn Graphics

- Applications of vector-drawn images.
- How vector-drawn images work?
- Vector-drawn images v/s bitmaps.

Applications of Vector-Drawn Images

Vector-drawn images are used in the following areas:

- Computer-aided design(التصميم بمساعدة الكمبيوتر) (CAD) programs.
- Graphic artists designing for the print media.
- 3-D animation programs.

How Vector-Drawn Images Work

- A vector is a line that is described by the location of its two endpoints.
- Vector drawing makes use of Cartesian(ديكارتي) co-ordinates.
- Cartesian coordinates are numbers that describe a point in two or three-dimensional space as the intersection of X, Y, and Z axis.

Vector-Drawn Images v/s Bitmaps

- Vector images use less memory space and have a smaller file size as compared to bitmaps.
- For the Web, pages that use vector graphics in plug-ins download faster, and when used for animation, draw faster than bitmaps.

Vector-Drawn Images v/s Bitmaps

- Vector images cannot be used for photorealistic images.
- Vector images require a plug-in for Web-based display.
- Bitmaps are not easily scalable and resizable.
- Bitmaps can be converted to vector images using auto-tracing.
- Most autotracing packages read files in a variety of bit-mapped formats (PCX and TIFF are the most common) and produce a file in a vector format such as *Encapsulated PostScript (EPS)*

3-D Drawing and Rendering

- 3-D animation tools.
- Features of a 3-D application.
- Panoramas.

3-D Animation Tools

3-D animation, drawing, and rendering tools include:

- Ray Dream Designer.
- Caligari True Space 2.
- Specular Infini-D.
- Form*Z.
- NewTek's Lightwave.

Features of a 3-D Application

- Modeling - Placing all the elements into 3-D space.
- Extrusion (قذف)- The shape of a plane surface extends some distance.
- Lathing (التدوير)- A profile of the shape is rotated around a defined axis.
- Rendering (تقديم)- Use of intricate(معقد) algorithms to apply user-specified effects.

Rendering Tools

- **Rendering**: is the process of generating an image from a model (or models in what collectively could be called a *scene* file), by means of computer programs.
- A scene file contains objects in a strictly defined language or data structure. It would contain geometry, viewpoint, texture, lighting, and shading information as a description of the virtual scene.
- The data contained in the scene file is then passed to a rendering program to be processed and output to a digital image or raster graphics image file.

- – **3D Studio Max**: rendering tool that includes a number of very high-end professional tools for character animation, game development, and visual effects production.
- – **Softimage XSI**: a powerful modeling, animation, and rendering package used for animation and special effects in films and games.

Rendering Tools Cont.

– **RenderMan**: rendering package, created by Pixar, is both a software and an application programming interface (API) for the network-distributed rendering of complex and potentially ray-traced three-dimensional views, employing a render farm of many client computers. The clients do not require 3D graphics cards but may benefit from them if they are available.

– **Maya**: competing product to Softimage (boasts impressive visual effects and game development toolset); it is a complete modeling package. Maya is the industry-leading package for 3D animation.

Panoramas

- Panoramic images are created by stitching together a sequence of photos around a circle and adjusting them into a single seamless bitmap.
- Software such as ULead Cool 360, and Panorama Factory are required in order to create panoramas.

Colors and Palettes in Multimedia

- Understanding natural light and color.
- Color palettes.

Understanding Natural Light and Color

- Light comes from an atom where an electron passes from a higher to a lower energy level.
- Each atom produces uniquely specific colors.
- Color is the frequency of a light wave within the narrow band of the electromagnetic spectrum, to which the human eye responds.

- Additive color.
- Subtractive(الاختزالي) color.
- Monitor-specific color.
- Color models.

Additive Color Vs Subtractive Color

Additive Color

- In the additive color method, color is created by combining colored light sources in three primary colors - red, green, and blue (RGB).
- TV and computer monitors use this method.

Subtractive Color

- In the subtractive color method, color is created by combining colored media such as paints or ink.
- The colored media absorb (or subtract) some parts of the color spectrum of light and reflect the others back to the eye.
- Subtractive color is the process used to create color in printing.
- The printed page consists of tiny halftone dots(نقاط صغيرة نصفية) of three primary colors- cyan (سماوي, pronounced syan), magenta(أرجواني), and yellow (CMY).

Monitor-Specific Colors

- Colors should be used according to the target audience's monitor specifications.
- The preferred monitor resolution is 800x600 pixels.
- The preferred color depth is 32 bits.
  - **color depth** or **bit depth** is the number of bits used to represent the color of a single pixel in a bitmapped image or video frame buffer.

Color Models

Models used to specify color in computer terms are:

- A **color model** is an abstract mathematical model describing the way colors can be represented as tuples of numbers
  - RGB model - A 24-bit methodology where color is specified in terms of red, green, and blue values ranging from 0 to 255.
  - HSB and HSL models – Color is specified as an angle from 0 to 360 degrees on a color wheel.
  - Other models include CMYK, CIE, YIQ, YUV, and YCC.

Color Palettes

- Palettes are mathematical tables that define the color of pixels displayed on the screen.
- Palettes are called ‘color lookup tables’ or CLUTs on Macintosh.
- The most common palettes are 1, 4, 8, 16, and 24-bit deep.

Dithering(التردد):

- Dithering is a process whereby the color value of each pixel is changed to the closest matching color value in the target palette.
- This is done using a mathematical algorithm.

Image File Types used in Multimedia

- Macintosh formats.
- Windows formats.
- Cross-platform formats.

Macintosh Formats

- On the Macintosh, the most commonly used format is PICT.
- PICT is a complicated and versatile(متنوع) format developed by Apple.
- Almost every image application on the Macintosh can import or export PICT files.
- In a PICT file, both vector-drawn objects and bitmaps can reside side-by-side.

Windows Formats

- The most commonly used image file format on Windows is DIB.
- DIB stands for Device-independent bitmaps.
- The preferred file type for multimedia developers in Windows is Resource Interchange File Format (RIFF).

Bitmap formats used most often by Windows developers are:

- BMP - A Windows bitmap file.
- TIFF - Extensively used in DTP packages.
    - **Desktop publishing** (also known as **DTP**) is the creation of documents using page layout software on a personal computer.
- PCX - Used by MS-DOS paint software.

Cross-Platform Formats

The image file formats that are compatible across platforms are:

- DXF - Used by CAD applications.
- Initial Graphics Exchange Standard (IGS or IGES) - Standard for transferring CAD drawings.
- JPEG and GIF - Most commonly used formats on the Web.

Summary

- The computer generates still images as bitmaps and vector-drawn images.
- Images can be incorporated in multimedia using clip arts, bitmap software, or by capturing, editing, or scanning images.
- Creating 3-D images involves modeling, extruding, lathing, shading, and rendering.
- Color is one of the most vital components of multimedia.

Multimedia
Audio

Venus Samawi
Isra University

Content

- Introduction to sound.
- Digital Audio Signals.
- Sound Sampling
- Sound Recording
- Sound Signal Form
- Sound Editing
- Size of a Digital Recording
- MIDI audio.
- Audio file formats.

Introduction to Sound

- Sound is energy, caused by molecules vibrating
- Too much volume can permanently damage your ears and hearing
- Vibrations in the air create waves of pressure that are perceived as sound.
- Sound waves vary in sound pressure level (amplitude) and in frequency or pitch (الدرجة).
- ‘Acoustics’ is the branch of physics that studies sound.
- Sound pressure levels (loudness or volume) are measured in decibels (dB).
- Multimedia sound is either digitally recorded audio or MIDI (Musical Instrumental Digital Interface) music.

Audio Signals

- Audio signals are continuous analog signals.

- **Digital audio** is created when you represent the characteristics of a sound wave using numbers—a process referred to as digitizing
- **Input**: microphones and then digitized and stored.
  - Audio files need to be compressed.
  - 1 Minute of CD quality audio requires 5 Mb.

Digital Audio

- Digital audio is a representation of the original sound
- Digital audio data is the actual representation of sound, stored in the form of samples.
- Samples represent the amplitude (or loudness) of sound at a discrete point in time.
- Quality of digital recording depends on the sampling rate, (or frequency) that is, the number of samples taken per second.
- It is used for music CD’s

Digitized Sound

- **Digitized sound** is sampled sound Every *n*th fraction of a second, a **sample** of sound is taken and stored as digital information in bits and bytes.
- The quality of this digital recording depends upon
  - How often the samples are taken (**sampling rate).**
  - How many numbers are used to represent the value of each sample (**bit depth**, **sample size**, resolution, or dynamic range).
- The value of each sample is rounded off to the nearest integer (quantization).

Sampling Rate (frequency)

- **Sampling rate** is measured in kHz, or thousands of samples per sec, and **Sound** usually compressed.
- The more often you take a sample and the more data you store about that sample, the finer the resolution and quality of the captured sound when it is played back. Since the quality of your audio is based on the quality of your recording and not the device on which your end user will play the audio.
- Digital audio is said to be **device independent**.
- The 3 sampling rates most often used in multimedia are:
  - 44.1 kHz (**CD-quality**),
  - 22.05 kHz, and
  - 11.025 kHz.

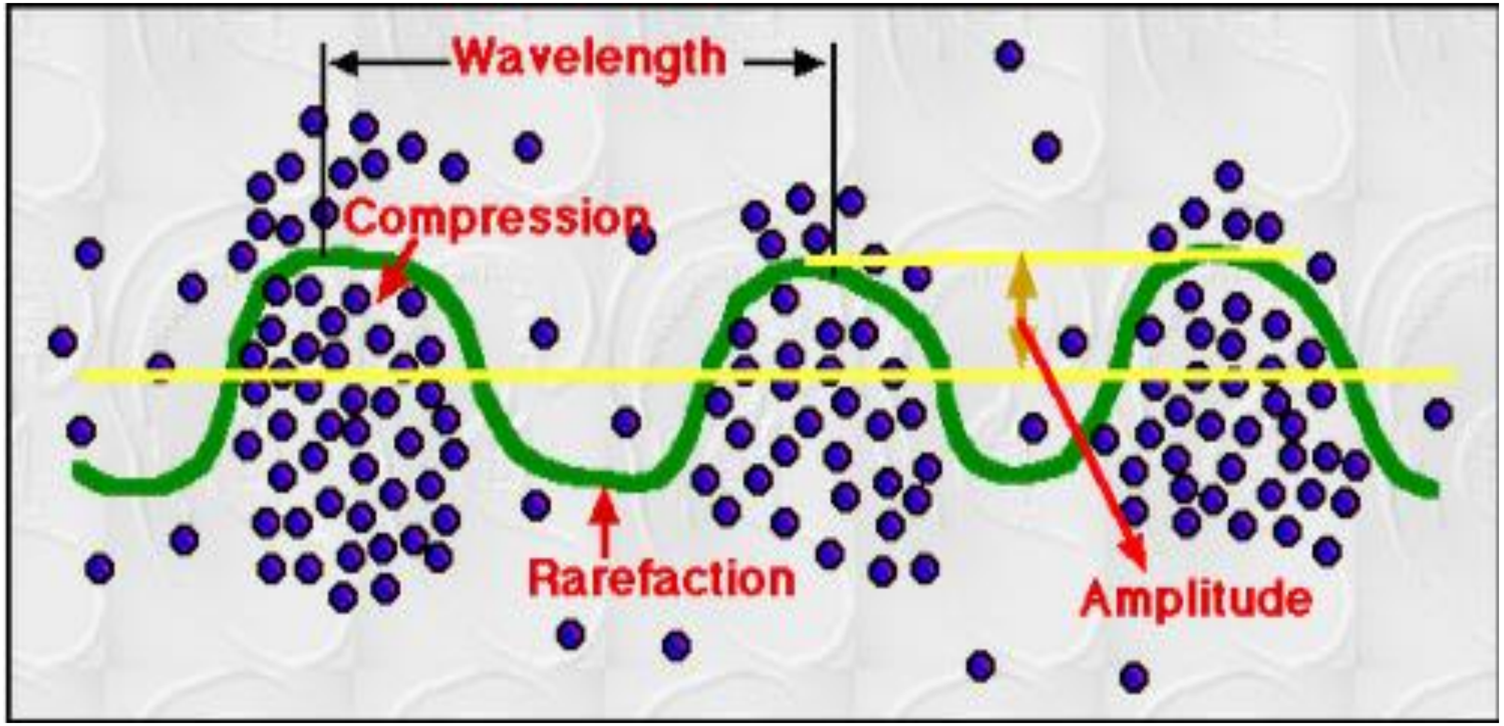
Sampling sizes

- Sample sizes are either 8 bits or 16 bits. The larger the sample size, the more accurately the data will describe the recorded sound
- An 8-bit sample size provides 256 equal measurement units to describe the level and frequency of the sound in a slice of time.
- A 16-bit sample size, on the other hand, provides a staggering 65,536 equal units to describe the sound in that same slice of time.

Sound Recording

- Using more bits for the sample size yields a recording that sounds more like its original. Recordings either Mono or stereo.
- Mono recordings are fine but tend to sound a bit “flat” and uninteresting
- To record stereo you need two microphones (left and right), and the sound file generated will require twice as much storage space as the mono file for the same length of play time.

Sound Signal Form

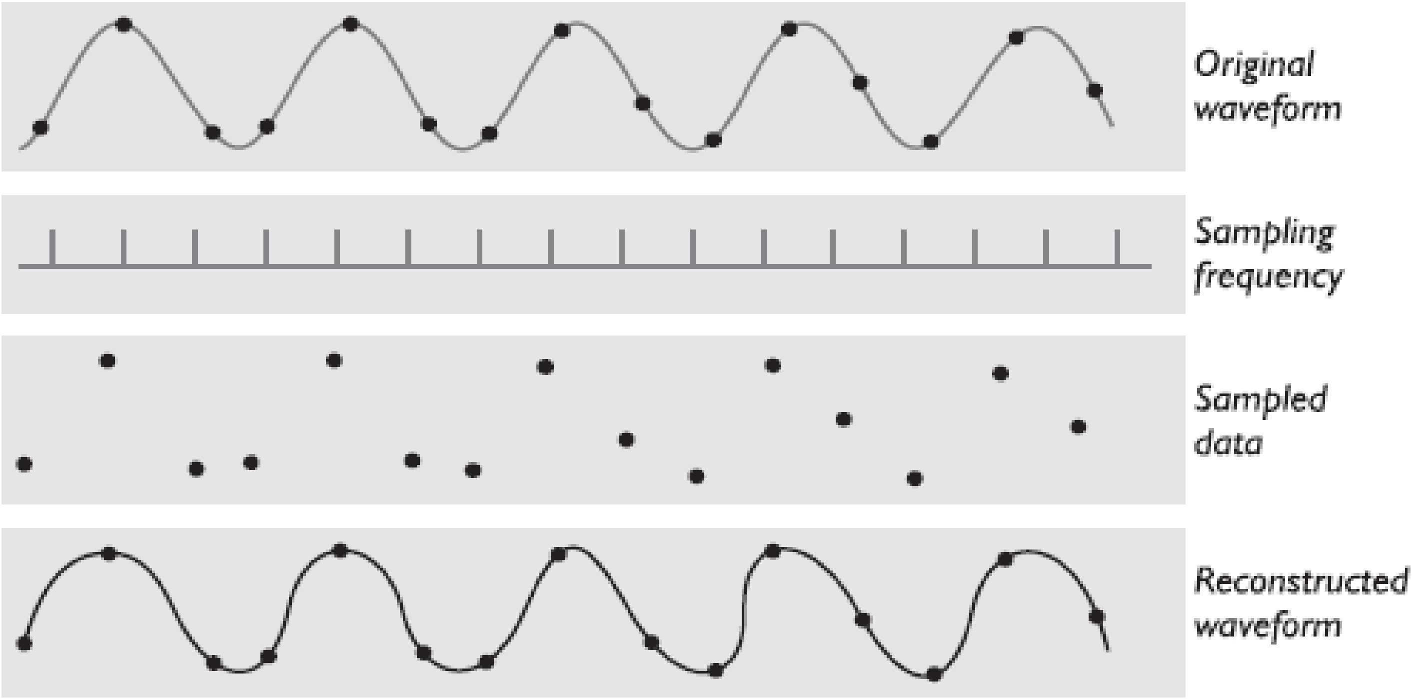


Amplitude(الغزارة): is the measure of the amount of energy in a sound wave.

- The number of bits used to describe the amplitude of sound wave when sampled, determines the sample size.

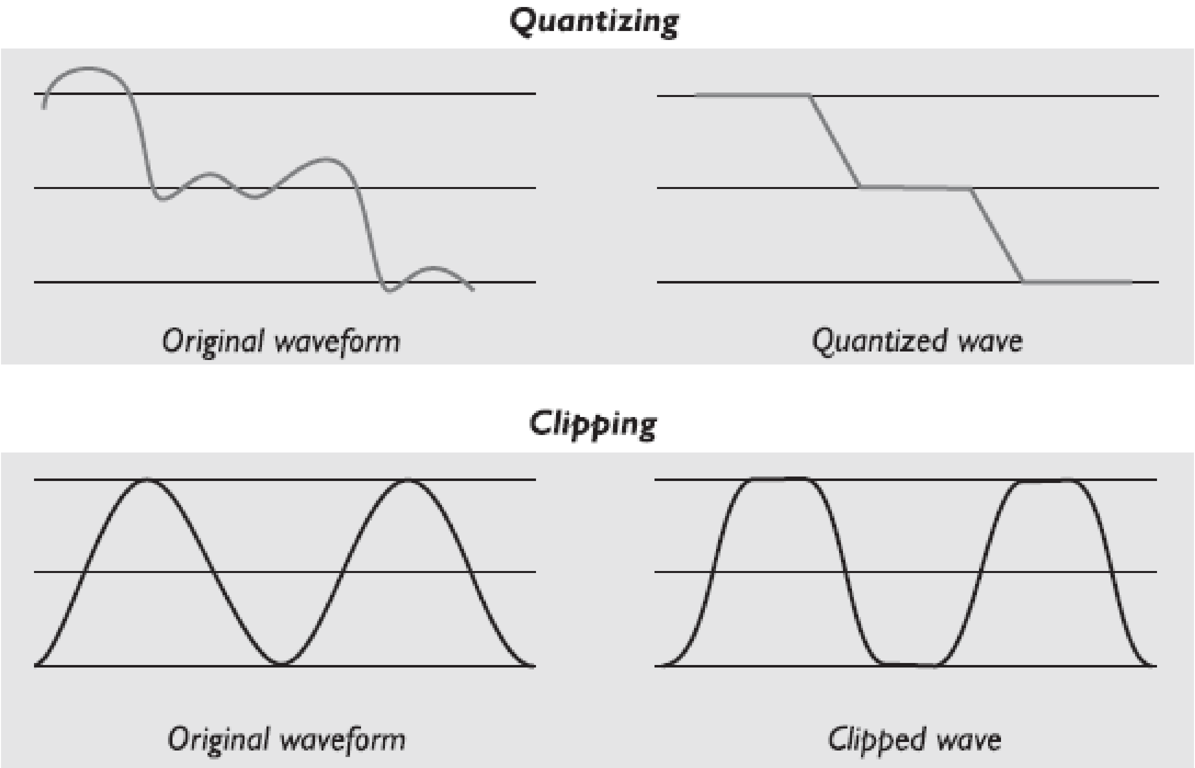
Rarefaction (التخلخل).

Constructing Original waveform



- It is impossible to reconstruct the original wave form is the sampling frequency is too low.

- The value of each sample is rounded off to the nearest integer (**quantization**), if the amplitude is greater than the intervals available, clipping of the top and bottom of the wave occurs



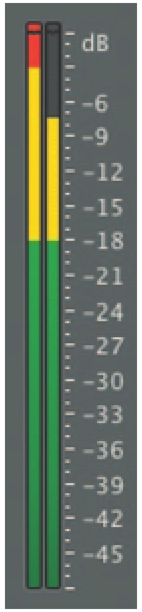
Using more
bits for the sample size yields a recording that sounds more like its original.

rounded off

- Take an example problem. Round 4685 to the nearest hundred.
    - Take the digit in the place being rounded off and highlight it. Here it is 6, because it is in the hundreds place. 4 '6' 85.
    - Look at the digit to the right, 8. If it is less than 5, leave the highlighted digit as is. If it is 5 or greater, increase the highlighted digit by 1. Since 8 is greater than 5, increase 6 to 7. So 4 '7' 85.
    - Replace digits to the right of the hundreds place by zeros. 4700. 4685 rounded to the nearest hundred is 4700.

Making Digital Audio Files

- You should focus on 2 crucial aspects of preparing digital audio files:
  - ✓ Balancing the need for sound quality against file size. Higher quality usually means larger files, requiring longer download times on the Internet and more storage space on CD or DVD.
  - ✓ Setting proper recording levels to get a good, clean recording.



- ***To avoid distortion***, do not cross over limit. If this happens,
  - ✓ lower your volume (either by lowering the input level of the recording device or the output level of your source) and try again.
  - ✓ Try to keep peak levels between –3 and –10.
  - ✓ In digital meter displays, if you see red, you are over the peak. Audacity is

Audacity : Sound Authoring Tool

- **Audacity** (http://audacity.sourceforge.net): is a free open-source sound editing application for Windows, Macintosh, and Linux. With such a tool you can create sound tracks and digital mixes.
- **Some basic sound editing operations:**
  - ✓ **Trimming:** Removing "dead air" or blank space from the front of a recording and any unnecessary extra time off the end.
  - ✓ **Splicing and Assembly:** remove the noises that during recording. Also, you may need to assemble longer recordings by cutting and pasting together many shorter ones.
  - ✓ **Volume Adjustments:** To provide a consistent volume level, select all the data in the file, and raise or lower the overall volume by a certain amount.

Sound Editing

Sound editor is used to **normalize** the assembled audio file to a particular level, say 80 percent to 90 percent of maximum (without clipping), or about –16 dB.

- **Format Conversion:** Data may be lost when converting formats.
- **Resampling or Down-sampling** If you have recorded and edited your sounds at 16-bit sampling rates but are using lower rates and resolutions in your project, you must resample or down-sample the file.

Sound Editing Cont.

- **Fade-ins and Fade-outs** Most programs offer enveloping capability, useful for long sections that you wish to fade in or fade out gradually. This enveloping helps to smooth out the very beginning and the very end of a sound file.
- **Equalization,** is the process of adjusting the balance between frequency components within an electronic signal. Adjust the amplitude of audio signals at particular frequencies.
- **Reversing Sounds** reverse all or a portion of a digital audio recording.
- **Multiple Tracks** Being able to edit and combine multiple tracks (for sound effects, voice-overs, music, etc.) and then merge the tracks and export them in a "final mix" to a single audio file is important.

Determining the Size of a Digital Recording (in bytes)

- **For a monophonic recording**

sampling rate×duration of recording (in sec.)×(bit resolution/8)×1

Example: The formula for

A 10-second recording at 22.05 kHz, 8-bit resolution is:

$$22050 \times 10 \times 8 / 8 \times 1 = 220{,}500 \text{ bytes.}$$

- **For a stereo recording**

sampling rate×duration of recording (in sec.)×(bit resolution/8)×2

Example: The formula for

A 10-second stereo recording at 44.1 kHz, 16-bit resolution is:

$$44100 \times 10 \times 16 / 8 \times 2 = 1{,}764{,}000 \text{ bytes.}$$

Steps to Bring an Audio Recording into a Multimedia Project

1. Determine the file formats that are compatible with your multimedia authoring software. Delivery medium(s) you will be using (for file storage and bandwidth capacity).
2. Determine the sound playback capabilities (codecs and plug-ins) that the end user's system offers.
3. Decide what kind of sound is needed (such as background music, special sound effects, and spoken dialog).
4. Decide where these audio events will occur in the flow of your project. Fit the sound cues into your storyboard, or make up a cue sheet.

Steps to Bring an Audio Recording into a Multimedia Project Cont.

5. Decide where and when you want to use either digital audio or MIDI data.
6. Acquire source material by creating it from scratch or purchasing it.
7. Edit the sounds to fit your project.
8. Test the sounds to be sure they are timed properly with the project's images.

Sound Testing

Sound testing may involve:

- *MIDI (Musical Instrument Digital Interface)* is a technical standard that describes a protocol, digital interface and connectors.
  - ✓ Used to allow a wide variety of electronic musical instruments, computers and other related devices to connect and communicate with one another.
  - ✓ A single MIDI link can carry up to 16 channels of information, each of which can be routed to a separate device.

- *Scripting languages* such as revTalk (RunRev), Lingo (Director), and ActionScript (Flash) provide a greater level of control over audio playback.

MIDI Audio

- MIDI is a shorthand representation of music stored in numeric form (a collection of numbers).
- A MIDI file is a list of commands that are recordings of musical actions, that when sent to a MIDI player results in sound
- It is not digitized sound.
- MIDI is device dependent.
- Since they are small, MIDI files embedded in web pages load and play promptly.
- Length of a MIDI file can be changed without affecting the music or degrading audio quality.
- Working with MIDI requires knowledge of music theory.

MIDI vs. Digital Audio

- MIDI data and digital audio are like vector and bitmapped graphics:
- Digital audio like bitmapped image – samples original to create a copy
- MIDI – like vector graphic- stores numeric data to recreate sound
- MIDI data is device dependent; digital audio is not
- MIDI sounds (like vector graphics) are different on different devices;
- Digital sounds are identical even on different computers or devices.

MIDI Versus Digital Audio

- MIDI files are much smaller than digitized audio.
- MIDI files sound better than digital audio files when played on a high-quality MIDI device.
- With MIDI, it is difficult to playback spoken dialog, while digitized audio can do so with ease.
- One requires knowledge of music theory in order to run MIDI, while digital audio does not have this requirement.

MIDI Advantages

- MIDI file are much more compact and take up less memory and system resources
- MIDI files embedded in web pages load and play much faster than digital
- With high quality MIDI devices, MIDI files may actually sound better than digital

MIDI Disadvantages

- MIDI represents musical instruments not sounds and will be accurate only if your playback device is identical to the production device
- MIDI cannot be easily used to reproduce speech

Digital Audio Advantages

- Digital audio sound is device independent
- A wide selection of software support is available for both MAC and PC
- A knowledge of music theory is not required for creating digital audio, but usually is needed for MIDI production

Choose MIDI data

- If you don’t have enough RAM memory, or bandwidth for digital audio
- If you have a high quality sound source
- If you have complete control over the playback hardware
- If you don’t need spoken dialog

Choose Digital Audio

- If you don’t have control over the playback hardware
- If you have the computing resources and bandwidth to handle the larger digital files
- If you need spoken dialog

Sound File Format

- On the Macintosh, digitized sounds may be stored as data files, resources, or applications such as AIFF or AIFC.
- In Windows, digitized sounds are usually stored as WAV files.
- Both Macintosh and Windows can use MIDI files (.mid)

Adding Sound to Multimedia Project

- Decide what sounds you will need and include them in the story board.
- The type of sound, whether background music, special sound effects, or spoken dialog, must be decided.
- Digital audio or MIDI data should be selected.
- Acquire source material (record/buy)
- Edit the sounds

Professional Sound

- Compression techniques reduce space but reliability suffers.
- Space can be conserved by down-sampling or reducing the number of sample slices taken per second.
- File size of digital recording (in bytes) = sampling rate × duration of recording (in secs) × (bit resolution/8) × number of tracks.
    - Digital audio tracks enable you (for example) to record a song from an audio CD, erase the singer's voice, and replace it with your own.

Production Tips

- Vaughn's Law of Minimums - there is an acceptable level of adequacy that will satisfy the audience;
- If your handheld microphone is good enough to satisfy you and your audience, conserve your money and energy.
- It is vital to maintain a high-quality database that stores the original sound material.
- Sound and image synchronization must be tested at regular intervals.
- The speed at which most animations and computer-based videos play, depends on the user's CPU.
- Copyrighted material should not be recorded or used without securing appropriate rights from owner or publisher.

Summary

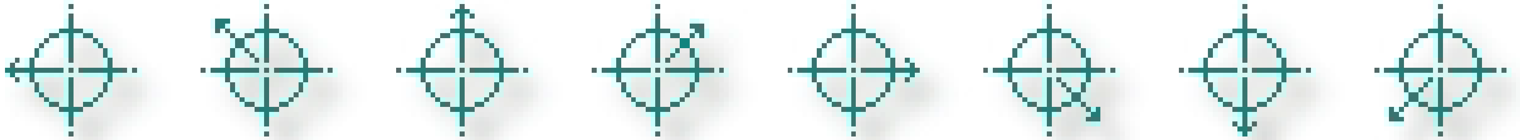
- Vibrations in air create waves of pressure that are perceived as sound.
- Multimedia system sound is digitally recorded audio or MIDI (Musical Instrumental Digital Interface) music.
- Digital audio data is the actual representation of a sound, stored in the form of samples.
- MIDI is a shorthand representation of music stored in numeric form.
- Digital audio provides consistent playback quality.
- MIDI files are much smaller than digitized audio.
- MIDI files sound better than digital audio files when played on high-quality MIDI device

What is Animation?

- Animation is defined as the acts that make static presentations come alive. It is a visual change over time and can add great power to your multimedia projects and web pages.
- It is concerned with the visual or aesthetic aspect of the project.
- Animation is an object moving across or into or out of the screen.

How to do Animation?

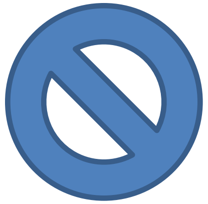
- Animation is possible because of a biological phenomenon known as persistence of vision and a psychological phenomenon called phi.
- In animation, a series of images are rapidly changed to create an illusion of movement.



When the images are progressively and rapidly changed, the arrow of the compass is perceived to be spinning.

Cont.

To make an object travel across the screen while it changes its shape, just change the shape and also move, or **translate**, it a few pixels for each frame. Then, when you play the frames back at a faster speed, the changes blend together and you have motion and animation.



Principles of Animation

Principles of Animation

- Television video creates 30 frames per second
- Movies are shot at a rate of 24 frames per second and replayed at 48 frames per second
- Both are used to create motion and animation
- Persistence of Vision-biological phenomenon-an object seen by the human eye remains mapped on the retina for a brief time after viewing.
- Causes the visual illusion of movement, when images change slightly and rapidly

Computer-Generated Animation

Animation space.

Animation techniques.

Animation Space

Animation can be rendered in:

- 2-D space - 2-D animations are very simple and static.
- 2½-D space - An illusion of depth is created through shadowing, highlighting, and forced perspective, though in reality‹ the image rests in two dimensions.
- http://ec.libsyn.com/p/7/9/0/790cbe118c0cbf3e/izzyvideo116free_fvvmd.mp4?d13a76d516d9dec20c3d276ce028ed5089ab1ce3dae902ea1d01c08031d4cb55f8dd&c_id=1502048
- 3-D space - Complicated and realistic animations are done in 3-D space.

Animation Space –(2D)

In 2-D space, the visual changes that bring an image alive occur on the flat Cartesian x and y axes of the screen.

- **Simple and static, not changing their position on the screen**: a blinking word, a **color-cycling** logo (where the colors of an image are rapidly altered according to a formula), a **cel animation**, or a button or tab that changes state on mouse rollover to let a user know it is active are all examples of **2-D animations**.
- **Path animation** in 2-D space increases the complexity of an animation and provides motion, changing the location of an image along a predetermined path (position) during a specified amount of time (speed).

Animation Space – (2 D) Cont .

- Authoring and presentation software such as Flash or PowerPoint provide user-friendly tools to compute position changes and redraw an image in a new location, allowing you to generate a bouncing ball or slide a corporate mascot onto the screen.
- Combining changes in an image with changes in its position allows you to “walk” your corporate mascot onto the stage. Changing its size from small to large as it walks onstage will give you a 3-D perception of distance.

Animation Space (2½-D)

- In **2½-D animation**, an illusion of depth (the z-axis) is added to an image through shadowing and highlighting, but the image itself still rests on the flat x and y axes in two dimensions. Embossing, shadowing, beveling, and highlighting provide a sense of depth by raising an image or cutting it into a background.
- Zaxwerks' 3D Invigorator (www.zaxwerks.com), for example, provides 3-D effects for text and images and, while calling itself "3D," works within the 2-D space of image editors and drawing programs such as Adobe Illustrator, Photoshop, Fireworks, and After Effects.

Animation Space (3D)

- In **3-D animation**, the software creates a virtual realm in three dimensions changes (motion) are calculated along all three axes (x, y, and z), allowing an image or object that itself is created with a front, back, sides, top, and bottom to move toward or away from the viewer, or, in this virtual space of light sources and points of view, allowing the viewer to wander around and get a look at all the object's parts from all angles.
- Such animations are typically rendered frame by frame by high-end 3-D animation programs such as NewTek's Lightwave or AutoDesk's Maya.
- Today, computers have taken the handwork out of the animation and rendering process, and commercial films such as *Shrek, Coraline, Toy Story,* and *Avatar* have utilized the power of computers.

Animation Process

Animation Process

Animation Process

The steps to be followed in creating animation are:

- Organize the execution in a series of logical steps.
- Choose an animation tool best suited for the job.
- Build and tweak the sequences.
- Post-process the completed animation.

Animation Techniques

Cel Animation

Computer Animation

Cel Animation

- Cel animation is a technique in which a series of progressively different graphics are used on each frame of movie film.
- The technique made famous by Disney
- Progressively different graphics on each frame of movie film
- Clear celluloid sheets were used to draw each frame

(24 frames/sec.× 60sec/min) = 1440 separate frames needed to produce one minute of a movie

- The term "cel" is derived from the clear celluloid sheets that were used for drawing each frame. Cel animation begins with **keyframes** (the first and last frame of an action).
- The series of frames in between the keyframes are drawn in a process called **tweening**

Tweening

Tweening is an action that requires calculating the number of frames between keyframes and the path the action takes. Then, actually sketching with pencil the series of progressively different outlines. As Tweening progresses, the action sequence is checked by flipping through the frames. The penciled frames are assembled and then actually filmed as a **pencil test** to check smoothness, continuity, and timing.

Principles of Computer Animation

Kinematics
Inverse kinematics
Morphing

Computer Animation

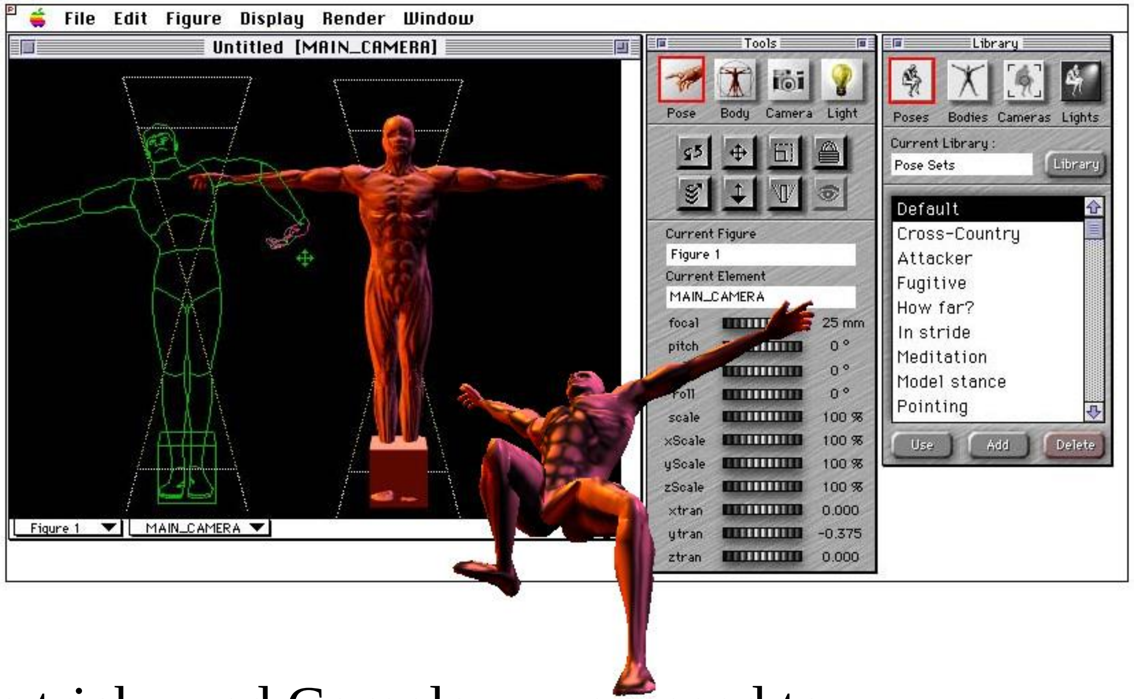
- Based on the same model as Cel animation
- Uses layers, keyframes, and tweening techniques
- Inks special methods for computing RGB pixel values, providing edge detection and layering so that images can blend or produce transparencies, inversions and effects
- Speed of the animation depends on computer;
- If it is display is greater than 1/15 sec, animation may seem slow and jerky

Computer Animation

- Computer animation is very similar to Cel animation. The primary difference is in how much must be drawn by the animator and how much is automatically generated by the software.

Kinematics

Kinematics is the study of motion of jointed structures (such as a walking man).



- Animating a walking step is tricky and Complex-: you need to calculate the position, rotation, velocity, and acceleration of all the joints and articulated parts involved: knees bend, hips flex, shoulders swing, and the head bobs.
- (http://my.smithmicro.com), a 3-D modeling program that provides preassembled adjustable human models (male, female, infant, teenage, and superhero) in many poses, you can pose figures in 3-D and then scale and manipulate individual body parts. Surface textures can then be applied to create muscle-bound hulks or smooth chrome androids

Inverse kinematics

- Inverse kinematics is the process of linking objects together and defining their relationships and limits and then dragging the parts and letting the computer calculate the result (for example, connecting hands and arms and bending the elbow in various directions)
- Fractal Design's Poser – a 3-D modeling program
- **Inverse kinematics** available in high-end 3-D programs such as Lightwave and Maya, is the process by which you link objects such as hands to arms and define their relationships and limits (for example, elbows cannot bend backward). Once those relationships and parameters have been set, you can then drag these parts around and let the computer calculate the result.

Morphing

- ***Morphing*** is the process of transitioning from one image to another. Transition not only between still images but often between moving images as well. Process involves connecting a series of key points, which are mapped from the start image to the end image to make a smooth transition

File Formats used in Animation

- AnimatorPro files. -.fli and .flc
- 3D Studio Max files. - .max
- SuperCard and Director files. - .pics
- Flash files - .fla and .swf
- Windows Media – .AVI, .ASF, or .WMV
- Apple Macintosh QuickTime – .QT or .MOV
- Motion Video – .MPG or .MPEG
- Shockwave – .DCR
- Animated GIF – .GIF
- Director (dir) compressed into a Shockwave animation file (dcr) for the web
- Compression for Director is 75%+ turning a 100k file into a 25k file

File Formats used in Animation

GIF89a file format:

- It is a version of the GIF image format.
- GIF89a allows multiple images to be put into a single file and then be displayed as an animation in the Web browser.
- Applications like BoxTop Software's GIFmation or ULead's GIF Animator are needed to create GIF89a animation.

Making Successful Animations

- Use animation carefully and sparingly.
- High quality animations require superior display platforms and hardware, as well as raw computing horsepower.
- File compression is very important when preparing animation files for the Web.

Making Animations that Work

- Use animations carefully so your screens don’t become too “busy”
- Animation tools
  - Director
  - Adobe GOLive
  - GIF animators

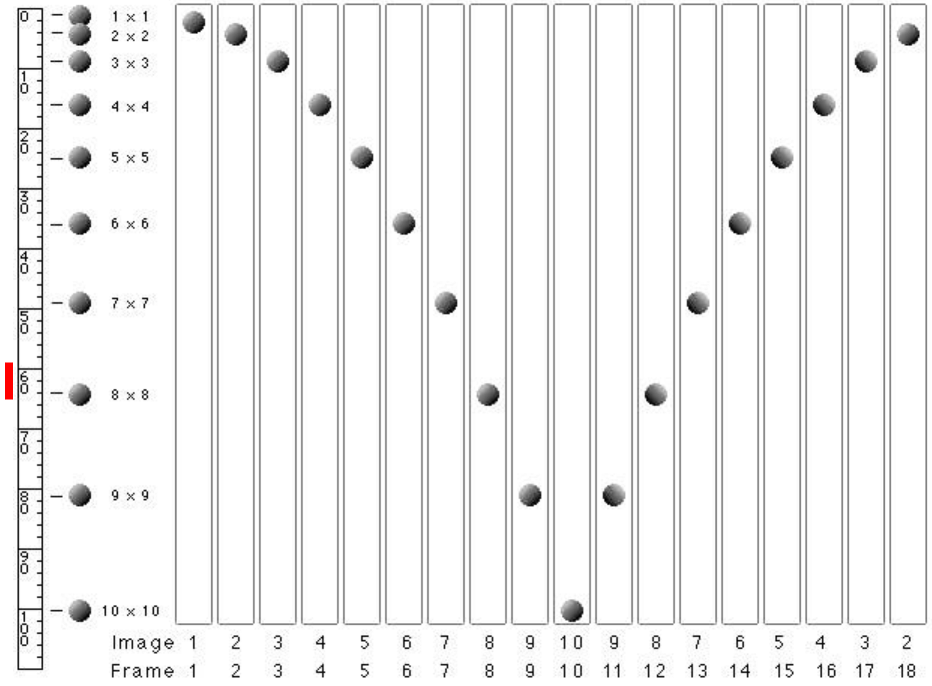
Creating Animation

- Software helps create objects such as:
- A rolling ball

Creating Animation

- Software helps create objects such as:
- A rolling ball
- A bouncing ball

$s = 1/2gt^2$



Bouncing Ball

- Requires a series of rotations
- A knowledge of physics ($s = 1/2gt^2$)
- Ball will uniformly accelerate and decelerate by squares 1,4,9,16,….

  (as Galileo discovered)

  (See examples, pp.329-334)

Creating Animation

- Software helps create objects such as:
  - A rolling ball

A bouncing ball▪

An animated scene•

Creating an Animated Scene

- A background is chosen
- Then an “actor” is video taped running against a blue or green screen
- A few frames of the running man are captured by a video capture board and the blue background is removed
- Finally, the action is placed on the background…. And King Kong, or Jurassic Park is born

Gif Animation Resources

- http://computers.lycos.com/downloads/dgif.asp
- http://shareware.lycos.com/tucows/imgani95.shtml

Multimedia Coding

Venus Samawi
Isra University

Introduction

- Coding Requirements
- Entropy Encoding
  - Content Dependent Coding
    - Run-length Coding
    - Diatomic Coding
  - Statistical Encoding
    - Huffman Coding
    - Arithmetic Coding
- Source Encoding
  - Predictive Coding
    - Differential Pulse Code Modulation
    - Delta Modulation
- Adaptive Encoding
- Image compression: JPEG Algorithm

Coding Requirements

- Storage Requirements
  - Uncompressed audio:
    - 8Khz, 8-bit quantization implies 64 Kbits to store per second
  - CD quality audio:
    - 44.1Khz, 16-bit quantization implies storing 705.6Kbits/sec
  - PAL video format:
    - 640X480 pixels, 24 bit quantization, 25 fps, implies storing 184,320,000 bits/sec = 23,040,000 bytes/sec
    - fps (Frames per second), used for measuring the frame rate in a moving image
- Bandwidth Requirements
  - uncompressed audio: 64Kbps
  - CD quality audio: 705.6Kbps
  - PAL video format: 184,320,000 bits/sec

- COMPRESSION IS REQUIRED!!!!!!!

Coding Format Examples

- JPEG for still images
- H.261/H.263 for video conferencing, music and speech (dialog mode applications)
- MPEG-1, MPEG-2, MPEG-4 for audio/video playback, VOD (retrieval mode applications)
- DVI for still and continuous video applications (two modes of compression)
    - Presentation Level Video (PLV) - high quality compression, but very slow. Suitable for applications distributed on CD-ROMs
    - Real-time Video (RTV) - lower quality compression, but fast. Used in video conferencing applications.

Coding Requirements

- Dialog mode applications
  - End-to-end Delay (EED) should not exceed 150-200 ms

    (refers to the time taken for a packet to be transmitted across a network from source to destination.)
  - Face-to-face application needs an EED of 50ms (including compression and decompression).
- Retrieval mode applications
  - *Fast-forward and rewind data retrieval* with simultaneous display (e.g. fast search for information in a multimedia database).
  - *Random access* to single images and audio frames, access time should be less than 0.5sec
  - *Decompression of images, video, and audio*
    - should not be linked to other data units
    - allows random access and editing

Coding Requirements

- Requirements for both dialog and retrieval mode applications
  - Support for scalable video in different systems.
  - Support for various audio and video rates.
  - Synchronization of audio-video streams (lip synchronization)
  - Economy of solutions
    - Compression in software implies a cheaper, slower, and low-quality solution.
    - Compression in hardware implies an expensive, faster, and high-quality solution.
  - Compatibility
    - e.g. tutoring systems available on CD should run on different platforms.

Classification of Compression Techniques

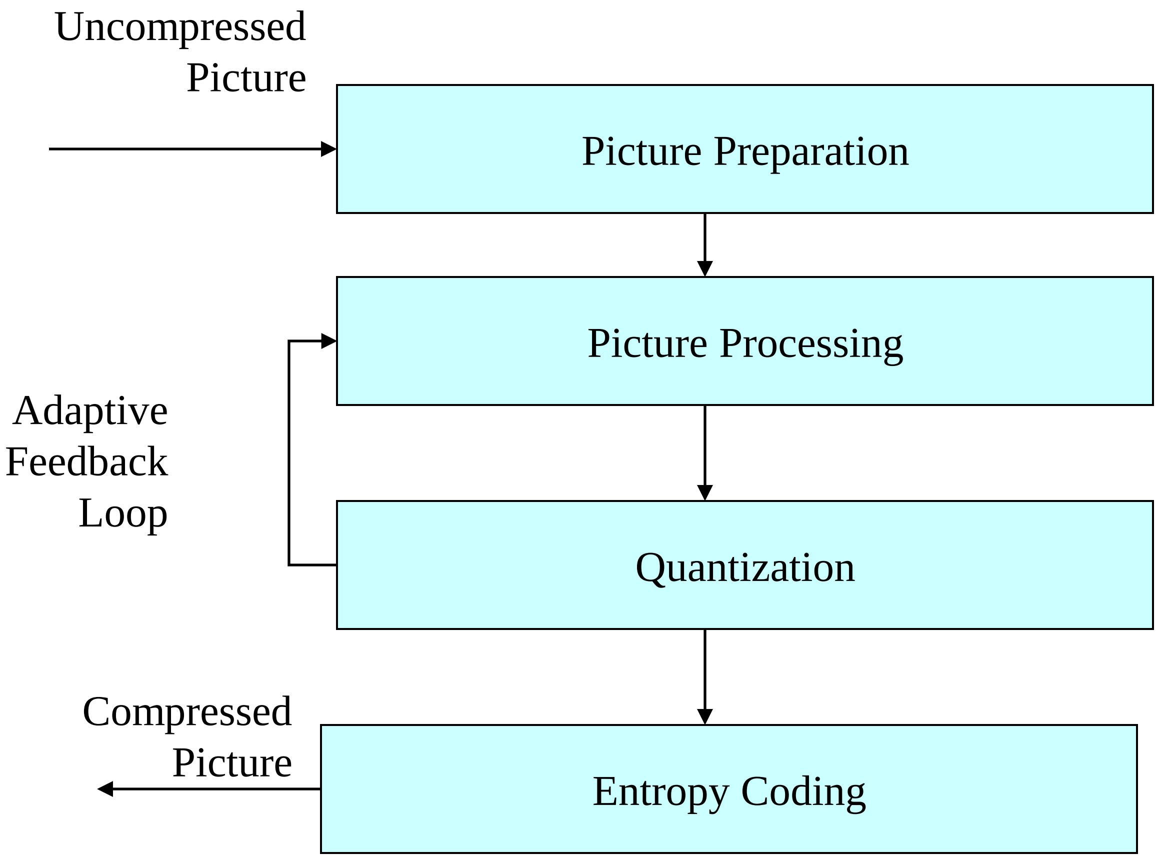
- ***Entropy Coding***
  - lossless encoding
  - used regardless of the media's specific characteristics
  - data were taken as a simple digital sequence
  - decompression process regenerates data completely
  - e.g. run-length coding, Huffman coding, Arithmetic coding
- ***Source Coding***
  - lossy encoding
  - the semantics of the data is considered
  - degree of compression depends on data content.
  - E.g. content prediction technique - DPCM, delta modulation
- ***Hybrid Coding (used by most multimedia systems)***
  - combine entropy with source encoding
  - E.g. JPEG, H.263, DVI (RTV & PLV), MPEG-1, MPEG-2, MPEG-4

Steps in Compression

- Picture preparation
  - analog-to-digital conversion
  - generation of appropriate digital representation
  - image division into 8×8 blocks
  - fix the number of bits per pixel
- Picture processing (compression algorithm)
  - transformation from time to frequency domain, e.g. DCT
  - motion vector computation for digital video.
- Quantization
  - Mapping real numbers to integers (***reduction in precision***).

  E.g. U-law encoding - 12bits for real values, 8 bits for integer values
- Entropy coding
  - compress a sequential digital stream without loss.

Compression Steps



Types of compression

- Symmetric Compression
  - Same time needed for decoding and encoding of data
  - Used for dialog mode applications
- Asymmetric Compression
  - Compression process is performed once and enough time is available, hence compression can take longer.
  - Decompression is performed frequently and must be done fast.
  - Used for retrieval mode applications

Entropy Coding - Run-length Encoding (RLE)

- Content dependent coding
- RLE replaces the sequence of the same consecutive bytes with the number of occurrences.
    - The number of occurrences is indicated by a special flag - “!”
- RLE Algorithm:
    - If the same byte occurred at least 4 times then count the number of occurrences
    - Write compressed data in the following format:

      “The counted byte! number of occurrences”
- Example
    - Uncompressed sequence - ABCCCCCCCCCDEFFFFGGG
    - Compressed sequence - ABC!9DEF!4GGG (from 20 to 13 bytes) Content-dependent

Variation of run-length coding - Diatomic Coding

- Determined frequently occurring pairs of bytes
- e.g. an analysis of the English language yielded frequently used pairs - “th”, “in”, “he” etc..
- Replace these pairs with single bytes that do not occur anywhere in the text (e.g. X)…
- can achieve a reduction of more than 10%

Statistical Encoding (Frequency Dependent)

- Fixed length coding
  - Use an equal number of bits to represent each symbol - the message of N symbols requires $L >= \log_2(N)$ bits per symbol.
  - Good encoding for symbols with equal probability of occurrence. Not efficient if the probability of each symbol is not equal.
- Variable length encoding
  - frequently occurring characters are represented with shorter strings than seldom occurring characters.
  - Statistical encoding depends on the occurrence frequency of a character or a sequence of data bytes.
  - Given a sequence of symbols: S1, S2, S3 and the probability of occurrence of each symbol $P(Si) = Pi$.

Huffman Encoding (Statistical encoding technique)

- Characters are stored with their probabilities
  - Number of bits of the coded characters differs.
    - ***The shortest code is assigned to the most frequently occurring character.***
  - To determine Huffman code, construct a binary tree.
    - ***Leaves*** are characters to be encoded
    - ***Nodes*** contain occurrence probabilities of the characters belonging to the subtree.
    - ***0 and 1*** are assigned to the branches of the tree arbitrarily - therefore different Huffman codes are possible for the same data.
    - ***Huffman table*** is generated.
      - ***Huffman tables must be transmitted with compressed data***

Example of Huffman Encoding

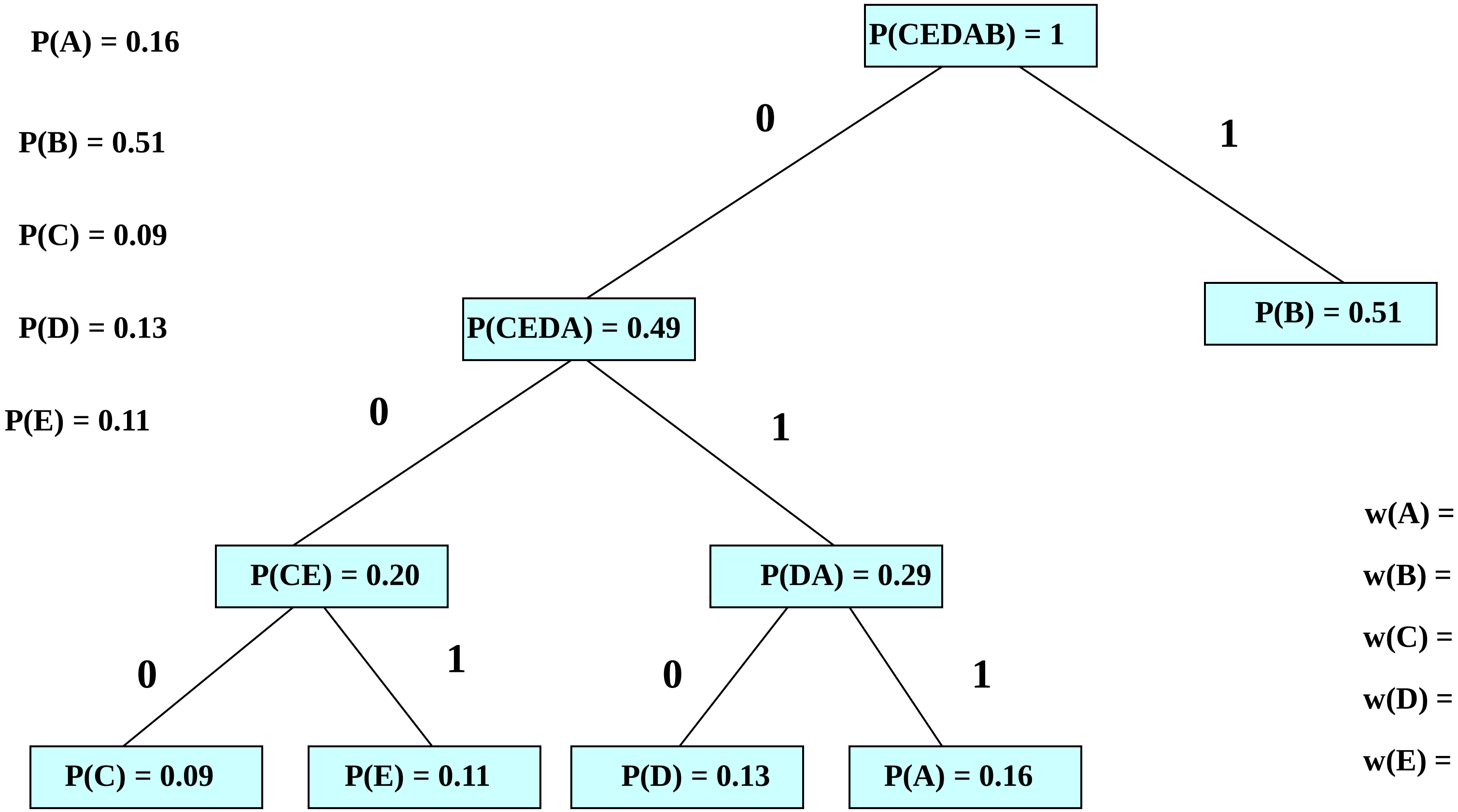
P(A) = 0.16

P(B) = 0.51

P(C) = 0.09

P(D) = 0.13

P(E) = 0.11



w(A) = 011

w(B) = 1

w(C) = 000

w(D) = 010

w(E) = 001

Arithmetic Encoding

- Each symbol is coded by considering prior data
  - encoded sequence must be read from the beginning;
    - no random access is possible.
  - Each symbol is a portion of a real number between 0 and 1.
- Arithmetic vs. Huffman
  - Arithmetic encoding ***does not encode each symbol separately***; Huffman encoding does.
  - Arithmetic encoding ***transmits only the length of the encoded string***; Huffman encoding ***transmits the Huffman table***.
  - Compression ratios of both are similar.

Source Encoding - Differential Encoding

- Coding is lossy.
- Consider sequences of symbols S1, S2, S3, etc. where values are not zeros but do not vary very much.
  - We calculate difference from previous value -- S1, S2-S1, S3-S2 etc.
- E.g. Still image
  - Calculate the difference between nearby pixels or pixel groups.
  - ***Edges*** characterized by large values, areas with similar luminance, and chrominance are characterized by small values.
  - Zeros can be compressed by run-length encoding and nearby pixels with large values can be encoded as differences.

Differential Encoding example

0	**0**	**0**	**0**	**0**
0	**255**	**250**	**253**	**251**
0	**255**	**251**	**254**	**255**
0	**0**	**0**	**0**	**0**

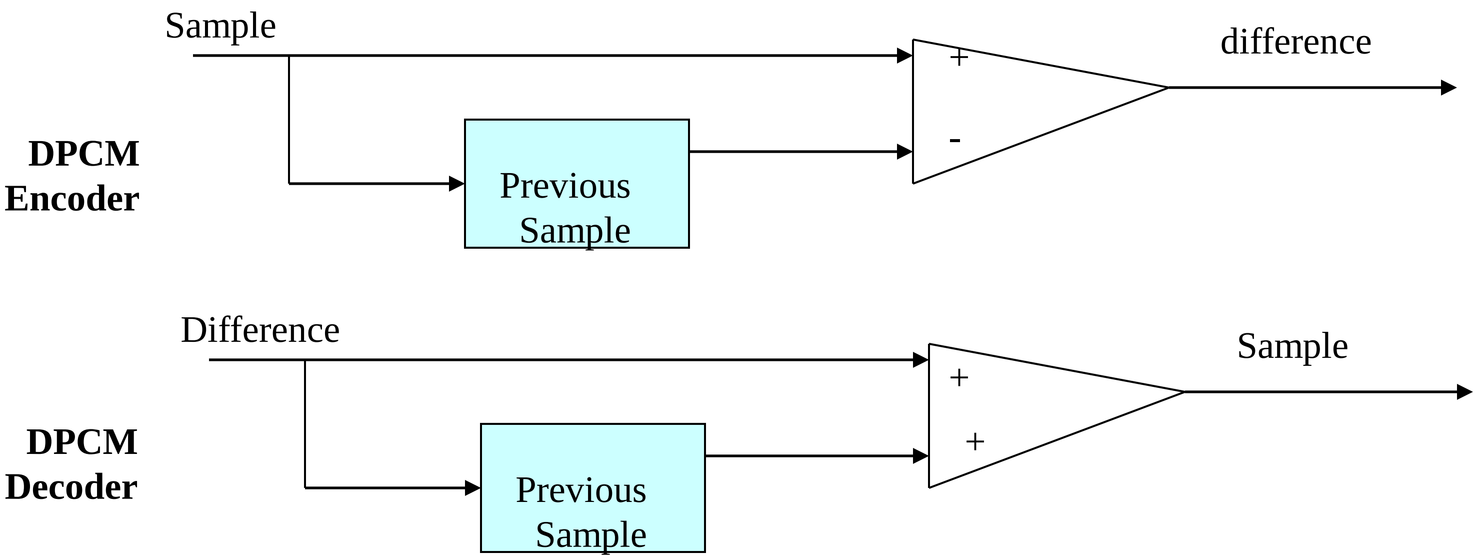
Compressed sequence: M5, 0, 255, -5, 3, -2, 0, 255, -4, 3, 1

Differential Encoding (cont.)

- Video applications
  - In a newscast or video phone, the background does not change often, hence we can use run-length encoding to compress the background.
  - In movies, the background changes - use motion compensation.
    - ✓ Compare blocks of 8×8 or 16×6 in subsequent pictures.
    - ✓ Find areas that are similar but shifted to the left or right.
    - ✓ Encode motion using a “motion vector”.

Differential Encoding for Audio

- Differential Pulse Code Modulation(DPCM)
  - When we use PCM, we get a sequence of PCM-coded samples.
  - Represent the first PCM sample as a whole and all the following samples as differences from the previous one.



DPCM Example

Samples

- 0 0.25 0.5 0.75 0.25 0 -0.25 -0.5

Digital Code

- 000 001 010 011 001 000 100 101

Difference

- 0 0.25 0.25 0.25 -0.5 -0.25 -0.25 -0.25

Need only 2 bits to encode difference

- 00 01 01 01 11 10 10 10

Delta Modulation

- Modification of DPCM
- Uses only 1 bit to encode difference.
    - Sets 1 if the difference increases
    - Sets 0 if the difference decreases
- Leads to inaccurate coding

Image compression: JPEG Algorithm

JPEG Algorithm

- **JPEG Algorithm**
- Traditional Encoder
- What's new in `cujpeg`
- Benchmark
- Conclusion

JPEG Algorithm

JPEG is an image compression method. The main steps of JPEG Encoding Algorithm are:

a) Divide image into 8×8 blocks
b) Convert [R,G,B] to [Y,Cb,Cr]
c) Perform down-sampling (optional)
d) Apply Discrete Cosine Transform(DCT) on each block
e) Perform Quantization
f) Perform zig-zag style
g) Perform lossless Entropy encoding (Run Length Coding & Huffman coding)

This is an example

This is an example

This is an example

Convert each block from [R,G,B] to [Y,Cb,Cr]

The precision of colors suffer less (for a human eye) than the precision of contours (based on luminance)

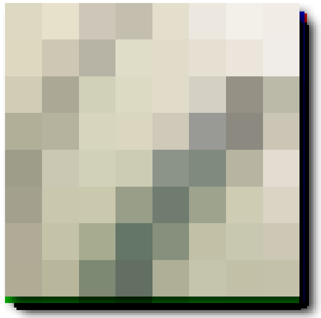
color space model: [R,G,B] per pixel

JPEG model: [Y, Cb, Cr]

Y = Brightness

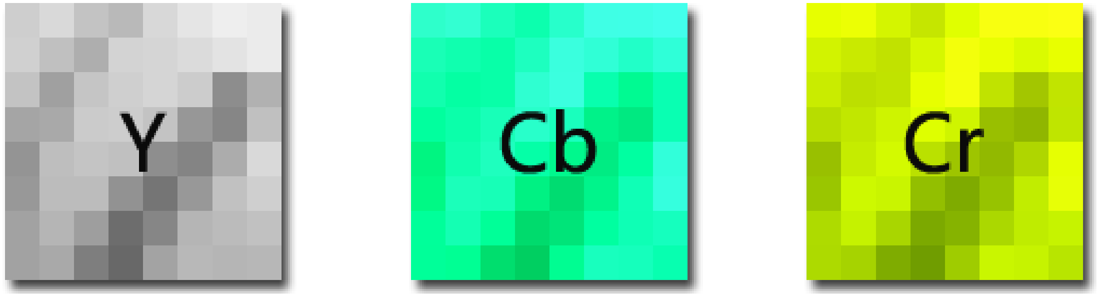
Cb = Color blueness

Cr = Color redness



8x8 pixel
1 pixel = 3 components

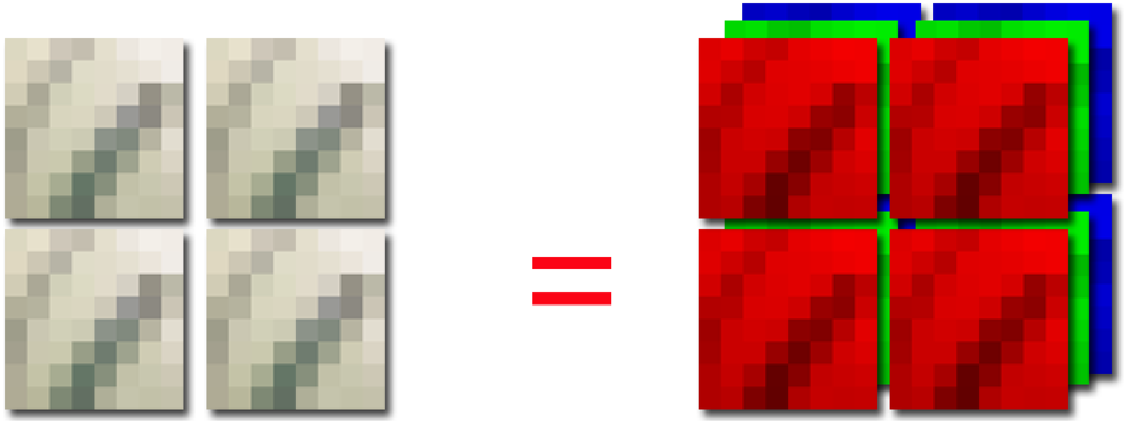
$$
\begin{aligned}
Y &= 0.299\,R + 0.587\,G + 0.114\,B \\
Cb &= -\,0.1687\,R - 0.3313\,G + 0.5\,B + 128 \\
Cr &= 0.5\,R - 0.4187\,G - 0.0813\,B + 128
\end{aligned}
$$



MCU with
sampling factor
(1, 1, 1)

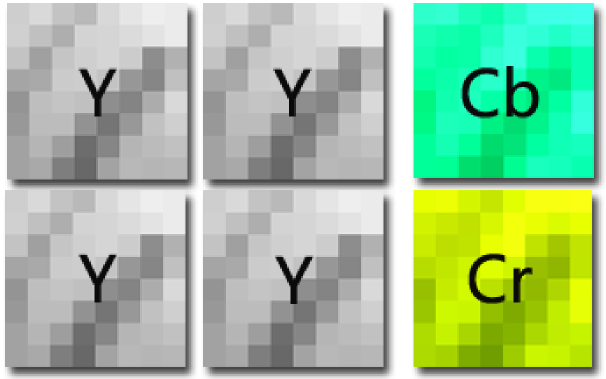
Y is taken every pixel , and Cb,Cr are taken for a block of 2x2 pixels

4 blocks
16 x16 pixel



MCU: **minimum coded unit:** The smallest group of data units that is coded.

Data size reduces to a half immediately



MCU with sampling factor (2, 1, 1)

2D IDCT: Bottleneck, the complexity of the algorithm is O(n^4)

$$p_{xy} = \frac{1}{4} \sum_{i=0}^{7} \sum_{j=0}^{7} C_i C_j G_{ij} \cos\left(\frac{(2x+1)i\pi}{16}\right) \cos\left(\frac{(2x+1)j\pi}{16}\right)$$

1D IDCT:

$$p_x = \frac{1}{2} \sum_{i=0}^{7} C_i G_i \cos\left(\frac{(2x+1)i\pi}{16}\right)$$

2-D is equivalent to 1-D applied in each direction

Kernel uses 1-D transforms

214	224	199	190	222	231	239	236
215	198	179	218	219	223	229	236
202	166	205	215	218	208	144	183
173	177	211	212	200	152	136	196
155	197	205	200	143	133	178	221
158	197	198	153	118	159	202	211
169	192	167	110	139	190	196	199
169	180	131	105	172	193	190	191

$- 128 =$

86	96	71	62	94	103	111	108
87	70	51	90	91	95	101	108
74	38	77	87	90	80	16	55
45	49	83	84	72	24	8	68
27	69	77	72	15	5	50	93
30	69	70	25	−10	31	74	83
41	64	39	−18	11	62	68	71
41	52	3	−23	44	65	62	63

Shift operations

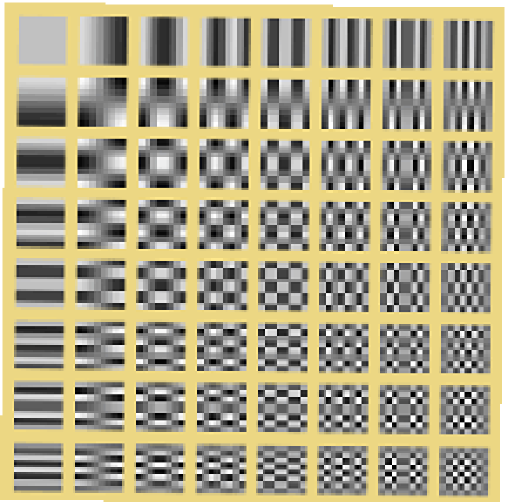
From [0, 255]

To [-128, 127]

$$S_{vu} = \frac{1}{4} C_u C_v \sum_{x=0}^{7} \sum_{y=0}^{7} s_{yx} \cos\frac{(2x+1)u\pi}{16} \cos\frac{(2y+1)v\pi}{16}$$

DCT Result

479	−35	52	−30	−7	−27	10	−3
141	11	−62	11	56	14	5	−5
41	−54	48	98	−35	−19	−14	8
22	−16	56	−48	−48	17	−24	−3
−4	5	−6	−16	14	−15	−15	9
−10	20	−11	9	−7	−15	22	12
−9	12	−12	5	−4	0	14	3
−2	6	−2	3	−3	0	8	−2



Meaning of each position in DCT result-matrix

Quantization:
Divide each element by QM

DCT result

479	−35	52	−30	−7	−27	10	−3
141	11	−62	11	56	14	5	−5
41	−54	48	98	−35	−19	−14	8
22	−16	56	−48	−48	17	−24	−3
−4	5	−6	−16	14	−15	−15	9
−10	20	−11	9	−7	−15	22	12
−9	12	−12	5	−4	0	14	3
−2	6	−2	3	−3	0	8	−2

/

Quantization Matrix
(adjustable according to quality)

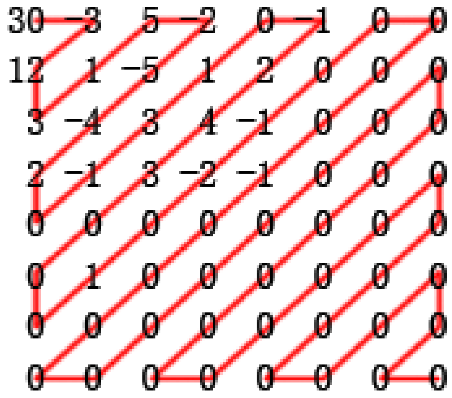
16	11	10	16	24	40	51	61
12	12	14	19	26	58	60	55
14	13	16	24	40	57	69	56
14	17	22	29	51	87	80	62
18	22	37	56	68	109	103	77
24	35	55	64	81	104	113	92
49	64	78	87	103	121	120	101
72	92	95	98	112	100	103	99

=

30	−3	5	−2	0	−1	0	0
12	1	−5	1	2	0	0	0
3	−4	3	4	−1	0	0	0
2	−1	3	−2	−1	0	0	0
0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

Quantization result

Zigzag reordering / Run Length



Quantization result

RLC Result:

[0, -3] [0, 12] [0, 3] [0, 1] [0, 5] [0, -2] [0, -5] [0, -4] [0, 2]

[1, -1] [0, 3] [0, 1] [1, -1] [0, 2] [0, 4] [0, 3] [3, 1] [1, -2] [0, -1]

EOB

[Number of Zero before me, my value]

Huffman encoding

Values	G	Real saved values
0	**0**	.
-1, 1	**1**	0,1
-3, -2, 2, 3	**2**	00, 01, 10, 11
-7,-6,-5,-4,5,6,7	**3**	000,001,010,011,100,101,110,111
.	**4**	.
.	**5**	.
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
.	.	.
-32767..32767	**15**	

RLC result:

`[0, -3] [0, 12] [0, 3]......EOB`

After group number added:

$[0,2,00_b]$ $[0,4,1100_b]$ $[0,2,00_b]$ ...... EOB

First Huffman coding (i.e. for $[0,2,00_b]$):

$[0,\ 2,\ 00_b] \Rightarrow [100_b,\ 00_b]$

(look up e.g. table AC Chron)

Total input: 512 bits,
Output: 113 bits output

Traditional Encoder