

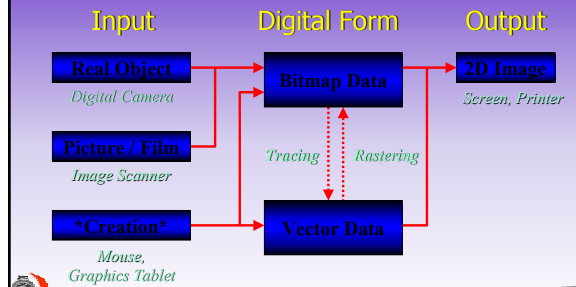
Graphics - 2D Graphics



1



2D Graphics - Digital Form



2



2D Graphics - Digital Form

- Usually graphics software creates, manipulates, and stores graphics as one of two types:

- Bitmaps
- Vectors

For bitmapped graphics, the computer stores information about the screen location and colour value of each dot.

A vector image is composed of a large number of lines and Circles, each reflecting a mathematical relationship.



3



Bitmaps



Vectors



4



Bitmaps

- Bitmap graphics are comprised of dots, called pixels, arranged in a grid. Your computer screen is a large grid of pixels.
- In a bitmap version of the leaf, the image would be determined by the location and color value of each pixel in the grid.
- Each dot is assigned a color. When viewed at the correct resolution, the dots fit together like tiles in a mosaic to form the image.



5



Vectors

- Vector graphics describe images using lines and curves, called vectors, that include color and position information.
- For example, the image of a leaf may be described by a series of points, the result of which is the leaf's outline.
- The leaf color is determined by the color of the outline, or stroke, and the color of the area enclosed by the outline, or the fill.

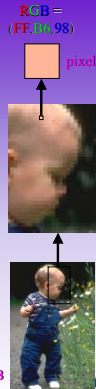


6



Bitmap Image

- Pixel based
 - Group of colored dots
- Best for real-world image
 - Photography, Painted picture
- Large data size
 - Needs **compression** for transfer
- Resolution Dependent
 - Not suitable for resizing/zooming



Full Color Windows BMP / 44KB

7

Bitmap Image - Compression

- Multimedia productions usually include numerous image and sound files.
- Storage space required can be quite extensive.
- Slow storage devices, narrow bandwidth of networks affect bit map images.
- Solution – **Compress** the files

Using algorithms that reduce the number of bytes needed to encode the data

8

Bitmap Image - Compression

- Two types : **Loss-less** , **Lossy**
- **Loss-less** Compression
 - Every pixel in the image is preserved during compression.
 - Can reproduce original image without loss
 - Not high compression ratio (~2.0)
 - Algorithms: RLE, LZW, etc.

9

Bitmap Image - Compression

- **Lossy** Compression
 - Reduce non-sensitive information to human eyes (not mathematical, but physiological method)
 - Cannot reproduce original image
 - Can specify the amount of information loss
 - High compression ratio (~100)
 - Algorithms: DCT, Wavelet , etc.

10

Compression Algorithms

	Algorithm	Basic Concept	Comp. Ratio	File Format
Loss-Less	RLE (Run-Length Encoding)	Compress repetitive data	~1.2	BMP
	LZW (Lempel-Ziv-Welch)	Build treed dictionary	~2.0	TIFF, GIF
Lossy	DCT (Discrete Cosine Transformation)	Transform to series of Cosine functions	~100	JPEG, MPEG1/2
	Colour Space Compression	Cut non-sensitive color information	~2	JPEG, (TV)
	Wavelet	Transform to series of Wavelet functions	~100	JPEG2000, MPEG4

11

Run Length Encoding (RLE)

- Many files, particularly image files, contains sequences of identical symbols.
 - Eg. In an image, a section of many adjacent pixels may all be the same colour .
 - Be encoded with the same bit pattern.
- RLE replaces sequence of identical bit patterns with
 - one instance of the pattern
 - Plus a number specifying how many times the pattern is to be repeated.
- Uses with BMP

12

Lempel-Ziv-Welch (LZW)

- Dictionary based coding algorithm
- Another Loss-Less compression algorithm.
- It was not designed specifically for graphics
- Data Dictionary is used to represent linear sequences of data in a uncompressed input stream. Then uses an algorithm similar to RLE.
- It does not work well with black and white or true colour images.
- Uses with GIF



13



Colour Space Compression

- Uses human eye characteristics
 - Less sensitive to color than lightness
 - Less sensitive to **Red** than **Green**
- YUV colour space
 - Originally developed for colour TV signal
 - Convert colour to Luminance(Y) and Chrominance (U,V) values



14



Mathematical Transformation

- **Convert images to mathematical functions**
 - Discrete Cosine Transformation (DCT)
Use series of cosine functions to approximate image.
Use with JPEG, MPEG 1/2
 - Wavelet Transformation
Use wavelet function to approximate image.
Use with JPEG2000, MPEG 4
- Both are **Lossy** Compression Algorithms



15



Bitmap Image – File Formats

- Industry standard
 - TIFF (Tagged Image File Format) - **Adobe/Silicon Graphics**
- Platform Standard
 - BMP - **Windows**
 - PICT - **Macintosh**
 - GIF (Graphics Interchange Format) - **CompuServe**
- International Standard
 - JPEG (Joint Photographic Experts Group) - **ISO 10918**
 - JPEG2000 - **ISO 15444**
 - PNG (Portable Network Graphic) - **MIT/W3C**

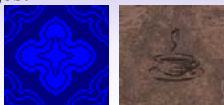


16



BMP

- The Microsoft Windows graphic file format
- Common file format used to display bitmap images.
- BMPs are used primarily on the Windows operating system.
- Many applications can import BMP images.



Two .bmp file come with windows O/S



17



TIFF (Tagged Image File Format)

- Highly flexible
 - Ability to handle various kinds of specialized image formats by using internal Tag
 - over-24bit images (**32, 36, 48, etc.**)
 - Alpha-channel (**Transparency**)
 - Multiple Layers
- For Professionals
 - Used in professional imaging industry
 - Medical, Publishing, Photographers



18



GIF (Graphics Interchange Format)

- Developed by Compuserve in 1987
- Designed to store multiple bitmap images into a single file for easy exchange over computer networks.
- Oldest graphic file format on the Web. Widely used in WWW
- If you want to be absolutely sure every one will see your graphics, make it GIF
- There are technically two types of Gif file: GIF87a, GIF89a



A Microsoft GIF image

19

GIF (Graphics Interchange Format) cont..

- Many useful features
 - Transparency (1 bit only)
 - Interlace (for fast perception over net) -GIF display in a series of four passes, 12.5%,25%, 50%,100% (not from top to bottom)
 - Animation (Cell Animation)
- Suitable for small pictures / icons
 - Flexible choice of bit-per-pixel (1~8)
 - Indexed color only (no full color support) max of 256 colours (8 bits)
- Uses LZW compression (loss less)

20

GIF (Graphics Interchange Format) cont..

- **When to use GIFs**
 - Well Suited for any image with areas of flat colour such as *logos, line art, icons, cartoon-like illustrations.*
 - If you want a portion of the image to be transparent.
 - Good option for adding simple animation to your page.
 - Not good for Photographic images. true colour information is lost (8 bit limit), JPEG better

21

GIF (Graphics Interchange Format) cont..

- GIFs can be created with a wide variety of graphics programs and utilities.
 - Image editing software
 - Web graphics tool
 - Vector drawing programs
 - Third party plug-ins
 - Shareware Utilities

22

- **Image editing software** : Industry standard – Adobe photoshop, (www.adobe.com) PaintShop Pro (www.jasc.com)
- **Web graphics tool** : Adobe Image-ready (comes with photoshop 6.0 up), Macromedia fireworks (macromedia.com)
fine tune controls over bit depth, dithering, and palette selection.
- **Vector drawing** : Macromedia Freehand (v7 higher), Adobe illustrator (v7 higher) – Not as effective at optimizing file sizes as Web graphics tools

23

- **Third part plug- ins software** – PhotoGIF (boxstopsoft.com), HVS ColourGIF (digfrontiers.com) Exceeds Photosops built-in features for fine tuning GIFs
- **Shareware** – GifConverter, Ulead GifSmartSaver see shareware.com

24

Portable Network Graphic (PNG)

- Designed to be the alternative of GIF
- Developed (1995) when Unisys threatened to enforce its patent on LZW compression, and collect license fees from developers of GIF supporting programs
 - No patent problem - free loss-less compression (zip)
- Many features
 - Up to 48bpp color depth
 - 16 bit Alpha channel
 - 2 dimensional interlace (Progressive image) ie. Horizontal and vertical filling
 - Gamma correction
- W3C recom.. [//www.w3.org/Graphics/PNG/](http://www.w3.org/Graphics/PNG/)



25



PNG cont...

- Not so popular
 - Lack of major breakthrough
- Not a JPEG substitute
 - Larger file size than JPEG
- Potential GIF substitute
 - Smaller file size than GIF
- W3C Recommendation in Oct. 1996
- PNG is the native file format for FireWorks
- See Libpng.org/pub/png, www.gimp.org



26



JPEG (Joint Photographic Expert Group)

- Designed for compressing either full-colour or gray-scale images of natural scenes.
- Compression (lossy) based on characteristics of human eyes
 - Less sensitive to color than lightness (YUV)
 - Good for photography or artistic image
 - Not Good for scientific image (uneven information loss)
- 24-Bit Colour, 16,777,216 colours
- Widely used in consumer market, WWW



27



JPEG Cont...

- Avoid using it for images
 - already forced into 256 colour palette or
 - for line drawings or
 - 1-bit black and white images.
- Block noise due to high compression



1:10



1:100

Square noise in high compression



28



JPEG Cont..

- Typical Compression Ratios
 - 10:1-20:1, High quality, little or no loss
 - 30:1-50:1, Moderate quality, best for Web
 - 60:1, 100:1, Poor quality, suitable for thumbnails and previews
- Image loss (lossy compression)
 - Can never get it back
- Variable compression levels
- JPEG Decompression
 - Needed before they can be displayed
 - it takes browser longer to decode and assemble a Jpeg than a Gif of the same file size.



29



JPEG Cont..

- When to use JPEGs
 - Ideal for full colour images such as photographs, paintings, watercolour illustrations, and gray colour images.
 - Not good for images with areas of solid colour such as logos, line art, and cartoon-like illustrations.



30



JPEG Cont..

- JPEG is supported by all the popular graphics tools.
 - Adobe Photoshop/ImageReady, JASC Paint Shop Pro, and Macromedia Fireworks etc.
 - Allow you to set the quality/compression level, save images in progressive JPEG format
- Plug-in utilities supports JPEG creation.
 - ProJPEG
 - HVS JPEG



31



JPEG2000

- New international standard (2001)
 - Wavelet compression
 - ~20% better compression than JPEG
 - Less noise in high compression ratio
 - No block noise like in JPEG
- www.jpeg2000-image-compression.com



32



JPEG2000 cont..

- Many advanced features
 - True progressive image
 - Support for Loss-less compression
 - Much better than LZW
 - Support for video Codec
 - Motion JPEG2000
 - ROI (Region of Interest) support
 - Select which region to compress more



33



JPEG vs JPEG2000

- JPEG Limitations
 - Compression system is *lossy*. When compressed and decompressed it loses data.
 - Inability to handle sharp edges within the image. Stronger the compression rate, it is worse.
- JPEG2000 compression
 - uses complex mathematical formulas representing image data.
 - High rate of compression with small amount of data.



34



If you want to use JPEG200....

- Many applications are adding support...
 - Graphics applications (see below)
 - Web browser (already available as plug-in)
 - Digital camera(not yet...)
- Graphics applications
 - irfanView32 ver. 3.61 or later (free)
<http://www.irfanview.com/>
 - Ulead PhotoImpact 7
 - LuraWave PhotoShop plug-in
<http://www.luratech.com/>



35



WBMP (Wireless Bitmap)

- is a graphic format created for mobile computing devices such as cell phones and PDAs.
- This format is used on Wireless Application Protocol (WAP) pages.
- WBMP is a 1-bit format, so only two colors are visible: black and white.



36



Vector Image

- A **Vector** is a line that described by the location of its two end points.
- A simple rectangle, for example, might be defined as follows:

RECT 0,0,200,200

RECT 0,0,200,200,RED,BLUE



37

BIT

Vector Image cont..

RECT 0,0,200,200,RED,BLUE

- Above concise description of the vector-drawn coloured square contains less than 30 bytes of alphanumeric data.
- Same square as an uncompressed bitmap image,
 - in black and white (1 bit colour depth per pixel)
 - require 5000 bytes to describe (200x200/8)
- Same square image made in
 - 256 colours (8-bit colour depth per pixel)
 - Require 40K to describe (200x200/8*8)



38

BIT

Vector Image cont...

- Vector Based
 - Group of mathematical shape data
- Best for Illustration / Technical Drawing
 - Fully editable, structured data
- Small data size
 - ~1/100 of comparable bitmap image
 - Suitable for slow network (Internet)
- Resolution Independent
 - Suitable for resizing/zooming/printing

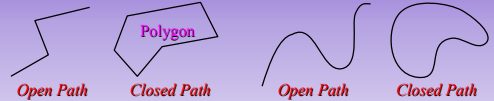


39

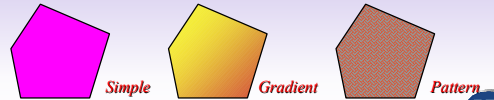
BIT

Vector Image - Basic Elements

- Line
- Curve



- Fill - for closed path only

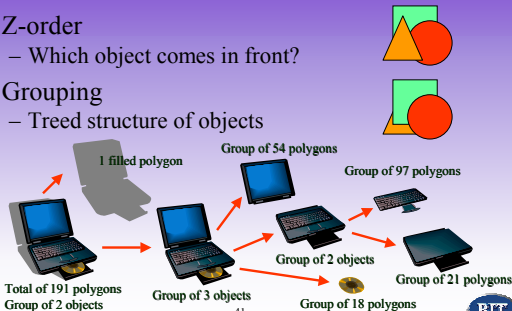


40

BIT

Vector Image - Z-order & Grouping

- Z-order
 - Which object comes in front?
- Grouping
 - Treed structure of objects

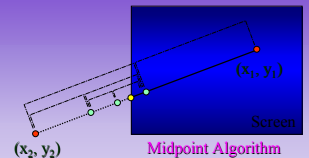


41

BIT

Vector Image - Drawing Algorithm

- Line
 - Many Algorithms
 - Clipping
- Curve
 - Parametric Curve
 - Draw curve as a function of independent parameter
 - B-Spline curve
 - Bézier curve



$$v = f(t); 0 \leq t \leq 1$$

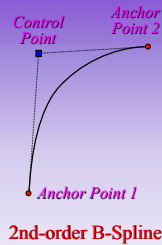


42

BIT

Vector Image - B-Spline Curve

- Simple or Complex
 - 2/3-order mathematical curve
 - 2nd-order is simple and fast (compared to Bézier curve)
 - Easy to modify curve locally
 - Needs many control points
- Not-so-widely used (in 2D)
 - TrueType Font
 - 3D Graphics → NURBS

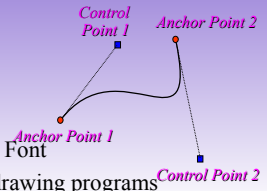


43



Vector Image - Bézier Curve

- De-facto standard of 2D curve
 - Cubic mathematical curve
 - Easy to control the shape
- Widely used
 - Adobe PostScript, Type1 Font
 - Almost all vector based drawing programs
 - Used in *Premier*, *Illustrator*, and *Flash*



44



Vector Image - Format

- Industry Standard
 - EPS (Encapsulated Post Script) – **Adobe** → **artistic drawings**
 - DXF – **AutoDesk** → **2D/3D Graphics**
- Platform Standard
 - WMF, EMF – **Windows**
- International Standard
 - CGM (Computer Graphics Metafile) – **ANSI/ISO**
 - SVG (Scalable Vector Graphic) – **(W3C recommendation)**



45



Vector Image - EPS

- PostScript based
 - PostScript – **Adobe**
 - Bézier-curve based page definition language
 - For printing complex page layout
 - Highly expressive for complex printing
 - Color separation, Layers, etc.
- For Professional Artist
 - Used in publishing / illustration industry
 - Not used in mechanical drawing → DXF
 - AI (Adobe Illustrator) format is also popular



46



Vector Image - WMF, EMF

- WMF (Windows Meta File)
 - Line-based (**No curve!**)
 - Designed for Microsoft Windows 3.1
 - Limited feature, but widely used in office market
- EMF (Enhanced Meta File)
 - Bézier curve-based
 - Designed for Microsoft Windows 95
 - Used for exchange of vector data internally between Windows applications



47



Vector Image – SVG (Scalable Vector Graphics)

- New international standard (2001)
 - XML based
 - Designed for WWW
 - Entirely described in XML tag (text)
 - Editable by text editor
- Wealth of features
 - Bézier curve, transparency, filter effects, animation, interactivity, etc.
- But Not adopted widely yet...
 - Because Flash is already too popular



48



PPM (Portable PixMap)

- Graphics format for X windows System
- Supports 24-bit colour bitmaps
- Can be manipulated using many public domain graphics editors such as **xv**.
- Used in X windows system for storing icons, pixmaps etc.



49

BIT

Converting between Bitmaps and Drawn images

- Can convert a drawing with vector drawn objects into a bitmap when saving.
 - Most drawing programs offer
- Converting bitmaps to drawn objects is more difficult.
- Utilities available for **autotracing**.
 - Compute the bounds of a bitmapped image
 - Compute the shapes of colour
 - Derive the polygon object that describe the image.
- **Illustrator, FreeHand** supports **Autotracing**



50

BIT

References

- Ref1 –Tay Vaughan, “Multimedia :Making it work” 6th edition, Tata McGraw-Hill, 2004
Page 264-272
- Ref1 – 5th edition Page 242-276
- Ref2 -71-79



51

BIT