



Graphics Overview

Multimedia Techniques & Applications
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1

Outline

- Overview
- Graphical modeling approaches: bitmapped / vector
- Comparisons of graphical modeling approaches

2

Graphics

- The software and hardware technologies used in computer system to create, modify, and display **still images** in a digital form
- Important because
 - Images are usually more expressive than pure texts
 - Images are the fundamentals of video, animation, and fonts

3

3

Digital Images

- Data can come from a number of ways



digitalization

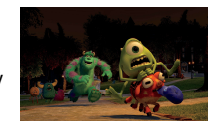


captured in digital form

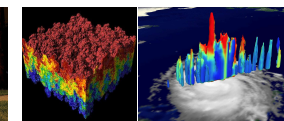


created by artists

generated by programs



3D graphics



visualization

4

4

1

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Image Display

- Monitor display pictures as a **rectangular array of pixels** (small, usually square, dots of color)
 - Merge optically when viewed at a suitable distance to produce the impression of continuous tones

Programs set the shade of grey or color (rendering)

reconstruct pixel data from the format

Graphical Modeling

store with a specific format

5

5

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Two Approaches for Graphical Modeling

bitmapped graphics

vector graphics

6

6

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Bitmapped Graphics

- An image is modelled by an array of pixel values
- Distinction between
 - Logical pixels**
 - Stored value in an image file
 - Physical pixels**
 - Physical dots on a display screen
- Operations for displaying
 - Scaling
 - Clipping

Image resolution (logical pixels)

physical pixels 1200 x 800

7

7

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Vector Graphics

- An image is modelled by the mathematical description of a collection of individual objects making up the image
 - Lines**
 - End points
 - Curves**
 - Control points
 - Shapes**
 - Shape-dependent parameters

object-oriented graphics !

8

8

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Vector Graphics (cont.)

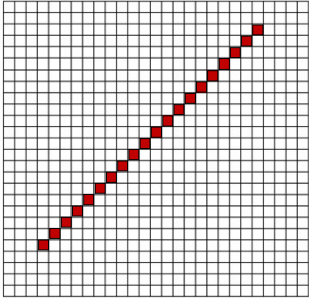
- Displaying a vector image requires some computation to be performed **in order** to interpret the model and generate an array of pixels to be displayed
- Example: line

Given $p1(x_1, y_1)$ and $p2(x_2, y_2)$ located on a line $y = mx + b$

→ Compute m

Assume $0 < m \leq 1$, we can draw the line by filling

$$y_{k+1} = y_k + m$$

$$x_{k+1} = x_k + 1$$


9

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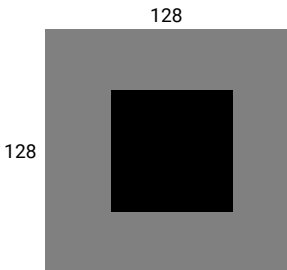
Comparisons: Image Size

10

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Image Size

- **Bitmapped images**
 - 128 x 128 = 16384 pixels
 - each pixel has 3 channels (rgb)
 - each channel requires 8 bits
 - 49152 bytes
- **Vector image**
 - 0.5 1.5 0.5 setrgbcolor
 - 0 0 128 128 rectfill
 - 0 0 0 setrgbcolor
 - 32 32 64 64 rectfill (in order)
 - 78 bytes (independent of any resolutions)



11

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Comparisons: Image Editing

12

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Editor for Bitmapped Images

- Example: Photopea
 - An online image editor for bitmapped image

painting operations & pixel adjustment

pixel point processing

pixel group processing

13

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Editor for Vector Graphics

- Example: Vectr
 - An online image editor for vector image

drawing operations

14

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Object Selection

- Intuitive for vector representation
- Painstaking for bitmapped image
 - Need to cutout the object boundary (e.g., magic wand)

15

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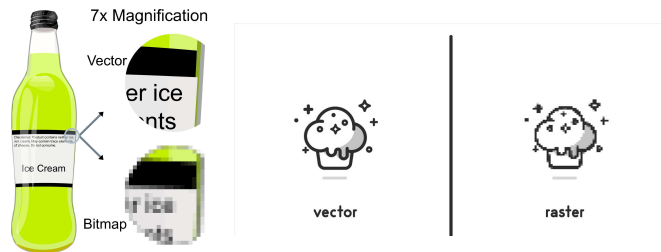
Pixel Point/Group Processing

- Example: blurring
 - Simple for bitmapped image
 - Additional work for vector graphics
 - Need to be first transformed into a bitmapped format
 - Difficult to transfer back to vector graphics for further editing

16

Resizing

- Bitmapped images need **down-sampling** or **up-sampling**, usually result in perceptual loss of quality
- Vector graphics is independent of the display resolution (on-line rendering based on math)



17

17

Resizing (cont.)

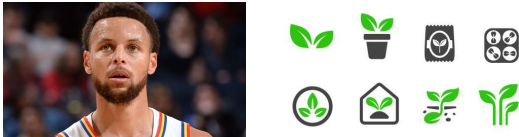
- Live Demo

18

18

Which Model Should Be Used?

- Depends on
 - **Type of content (target of the image)**
 - Bitmapped images provide better control of pixel values, thus being more suitable for natural images
 - Vector graphics are resolution independent, thus being more suitable for texts and icons



- **Memory requirement**
- **Display efficiency**

19

19

Graphic Model Conversion

20

20

Vector Graphics to Bitmapped Images

- Easy
- Used the same algorithm that are used to display the image on a monitor
 - **However, will lose all its vector properties after the conversion**

21

21

Bitmapped Images to Vector Graphics

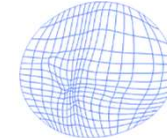
- Very difficult to do well
- Require tools to identify the boundaries of the shapes and shades within the images
- Also require a method to approximate the boundary using the available sorts of curves, lines, and shapes
- Finally, difficult to produce the color textures



input bitmapped image



Adobe Live Trace



Sun et al., SIGGRAPH 07

22

22

Layers

23

23

Layers

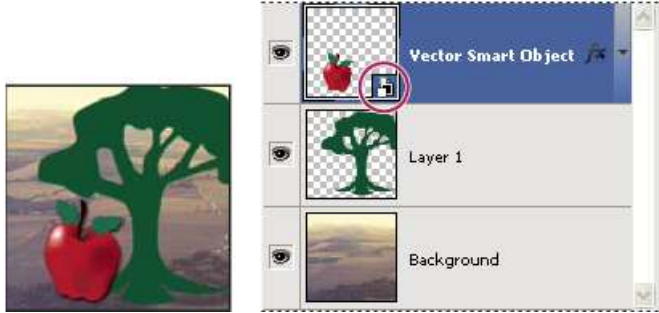
- First introduced in Photoshop 3
- Work like an overhead projector transparency
 - Allow to draw on parts of the layer, leaving some of it transparent
 - An image can be constructed by stacking layers on top of each other
- One of the most significant ways in which digital technology has affected how artists work
- Supported in both bitmapped and vector graphics editors

24

24

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Application: Object Distinguish




The screenshot shows the Photoshop Layers panel with three layers: 'Vector Smart Object' (containing an apple and a tree), 'Layer 1' (containing a tree), and 'Background' (containing a landscape). The 'Vector Smart Object' layer is highlighted with a red circle and a lock icon, indicating it is a Smart Object.

25

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Application: Digital Tracing Paper

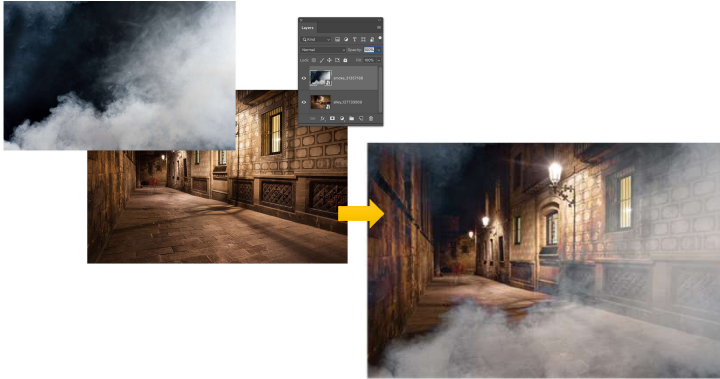


A hand is shown using a stylus to trace a drawing on a digital tablet. A white cylindrical object is placed on the tablet. The drawing is a colorful anime-style character.

26

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Application: Image Composition



The diagram illustrates image composition. It shows a source image of a hallway, a destination image of a hallway with smoke, and a final composed image. A yellow arrow points from the source image to the final composed image.

27

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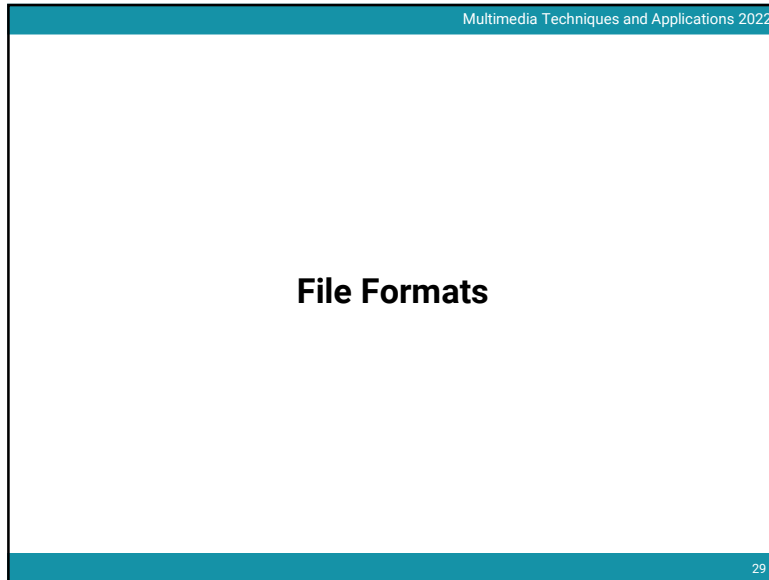
Application: Image Composition (cont.)

- Perez et al., Poisson Image Editing, SIGGRAPH 2003



The diagram illustrates Poisson Image Editing. It shows source/destination images, cloning, and seamless cloning. The source/destination images show a person in a pool. The cloning image shows the person in a pool with a red outline. The seamless cloning image shows the person in a pool with a red outline and a yellow outline.

28



29

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File Formats of Bitmapped Images

- Related to the way of compressing data
 - **Lossless compression**
 - GIF (Graphics Interchange Format)
 - TODO: Is GIF still only restricted to 256 colors?
 - PNG (Portable Network Graphics)
 - BMP (Windows Bitmap)
 - TIFF (Tagged Image File Format)
 - TGA (Truevision TGA, TARGA)
 - **Lossy compression**
 - JPEG (Joint Photographic Experts Group)
 - TIFF (Tagged Image File Format)

30

30

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File Formats of Vector Graphics

- Related to different applications
 - PostScript
 - EPS (encapsulated PostScript)
 - SVG (Scaleable Vector Graphics)
 - SWF (Small Web Format)
 - PDF (Portable Document Format)
 - AI (Adobe Illustrator Artwork)

31

31