

Introduction to Computer Graphics

1.1 What is computer graphics?

It would be difficult to overstate the importance of computer and communication technologies in our lives. Activities as wide-ranging as film making, publishing, banking, and education have undergone revolutionary changes as these technologies alter the ways in which we conduct our daily activities. The combination of computers, networks, and the complex human visual system, through computer graphics, has been instrumental in these advances and has led to new ways of displaying information, seeing virtual worlds, and communicating with both other people and machines.

Computer graphics is concerned with all aspects of producing pictures or images using a computer.

“**Computer graphics**” also refers to the **tools** used to make such pictures.

There are both **hardware** and **software** tools. *Hardware* tools include video monitors and printers that display graphics, as well as input devices like a mouse or trackball that let a user point to items and draw figures. The computer itself, of course, is a hardware tool, along with its special circuitry to facilitate graphical display or image capture.

As for *software* tools, you are already familiar with the usual ones: the operating system, editor, compiler, and debugger, that are found in any programming environment. For graphics there must also be a collection of “graphics routines” that produce the pictures themselves.

Computer graphics is a very appealing field of study. You learn to write programs that create pictures, rather than streams of text or numbers. Humans respond readily to pictorial information, and are

able to absorb much more information from pictures than from a collection of numbers.

People study computer graphics for many reasons. Some just want a better set of tools for plotting curves and presenting the data they encounter in their other studies or work. Some want to write computer animated games, while others are looking for a new medium for artistic expression. Everyone wants to be more productive, and to communicate ideas better, and computer graphics can be a great help.

1.2 Application of Computer Graphics

- 1. Paint programs:** Allow you to create rough freehand drawings. The images are stored as bit maps and can easily be edited. It is a graphics program that enables you to draw pictures on the display screen which is represented as bit maps (bit-mapped graphics).
- 2. Illustration/design programs:** Illustration/design programs are often called draw programs. Presentation graphics software: Lets you create bar charts, pie charts, graphics, and other types of images for slide shows and reports. The charts can be based on data imported from spreadsheet applications.
- 3. Animation software:** Enables you to chain and sequence a series of images to simulate movement. Each image is like a frame in a movie. It can be defined as a simulation of movement created by displaying a series of pictures, or frames. A cartoon on television is one example of animation.
- 4. CAD software:** Enables architects and engineers to draft designs. It is the acronym for computer-aided design. A CAD system is a combination of hardware and software that enables engineers and architects to design everything from furniture to airplanes. In addition to the software, CAD systems require a

high-quality graphics monitor; a mouse, light pen, or digitizing tablet for drawing; and a special printer or plotter for printing design specifications.

5. **Desktop publishing:** Provides a full set of word-processing features as well as fine control over placement of text and graphics, so that you can create newsletters, advertisements, books, and other types of documents. It means by using a personal computer or workstation high-quality printed documents can be produced. A desktop publishing system allows you to use different typefaces, specify various margins and justifications, and embed illustrations and graphs directly into the text. The most powerful desktop publishing systems enable you to create illustrations; while less powerful systems let you insert illustrations created by other programs.
6. **Virtual –Reality Environments:** a more recent application of computer graphics is in the creation of Virtual –Reality Environments in which a user can interact with the objects in a three-dimensional scene.
7. **Entertainment:** Television production, motion picture ,and music videos routinely use computer graphics method.

1.3 Elements of Pictures Created in Computer Graphics

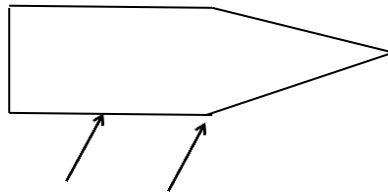
What makes up a computer drawn picture? The basic objects out of which such pictures are composed are called output primitives. One useful categorization of these is:

- polylines
- text
- filled regions
- raster images

1. Polylines

A **polyline** is a connected sequence of straight lines.

When there are several lines in a polyline each one is called an **edge**, and two adjacent lines meet at a **vertex**.



Edge vertex

Figure 1.1 Example of Edge and Vertex.

A **polyline** need not form a closed figure, but if the first and last points are connected by an edge the polyline is a **polygon**.

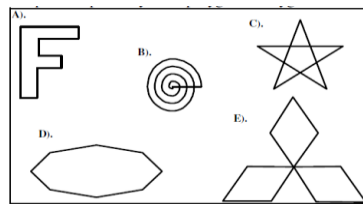


Figure 1.2 Examples of polygons.

For instance, the polyline shown in Figure 1 is given by the sequence $(2, 4), (2, 11), (6, 14), (12, 11), (12, 4), \dots$ (what are the remaining vertices in this polyline?).

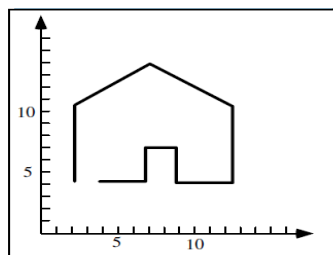


Figure 1.3 An example polyline.

Attributes of Lines and Polylines

The attributes of a graphic primitive are the characteristics that affect how it appears, and some Important attributes of a polyline are the

color and thickness of its edges, the manner in which the edges are dashed, and the manner in which thick edges blend together at their endpoints. Typically all of the edges of a polyline are given the same attributes.

2. Text

Some graphics devices have two distinct display modes, a text mode and a graphics mode. The text mode is used for simple input/output of characters to control the operating system or edit the code in a program.

Text displayed in this mode uses a built-in character generator. The character generator is capable of drawing alphabetic, numeric, and punctuation characters, and some selection of special symbols such as ♥, ð, and ⊕.

Compare with the *graphic mode*, the PC's **text mode** is easy to use. Displaying information on the screen is as simple as placing ASCII char in specific memory location. The text screen is divided into 80 column and 25 rows. The **graphic mode** requires a completely different orientation instead of character; you have **pixels**, the smallest picture element on your computer display. Today most screens can display text and graphics.

Attributes of Text

There are many text attributes, the most important of which are typeface, color, size, spacing, and Orientation.

A font is a specific set of character shapes (a typeface) in a particular style and size.

2. Filled Regions

The filled region (sometimes called “fill area”) primitive is a shape filled with some color or pattern. The boundary of a filled region is often a polygon

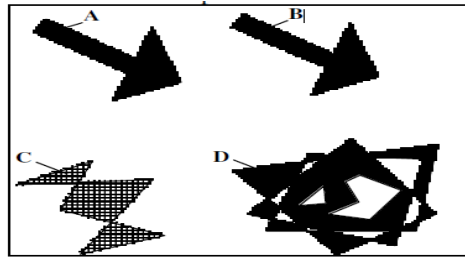


Figure 1.4 Examples of filled Polygons.

3. Raster Image.

A **raster image** It is made up of many small “cells”, in different shades of gray, The individual cells are often called “pixels” (short for “picture elements”). Normally your eye can’t see the individual cells; it blends them together and synthesizes an overall picture.

A raster image is stored in a computer as an array of numerical values. This array is thought of as being rectangular, with a certain number of rows and a certain number of columns. Each numerical value represents the value of the pixel stored there. The array as a whole is often called a “**pixel map**”. The term “**bitmap**” is also used. A simple figure represented as a bitmap.

Figure 1.5 shows a simple example where a figure is represented by a 17 by 19 array (17 rows by 19 columns) of cells in three shades of gray. Suppose the three gray levels are encoded as the values 1, 2, and 7. Figure 1.20b shows the numerical values of the pixel map for the upper left 6 by 8 portion of the image.

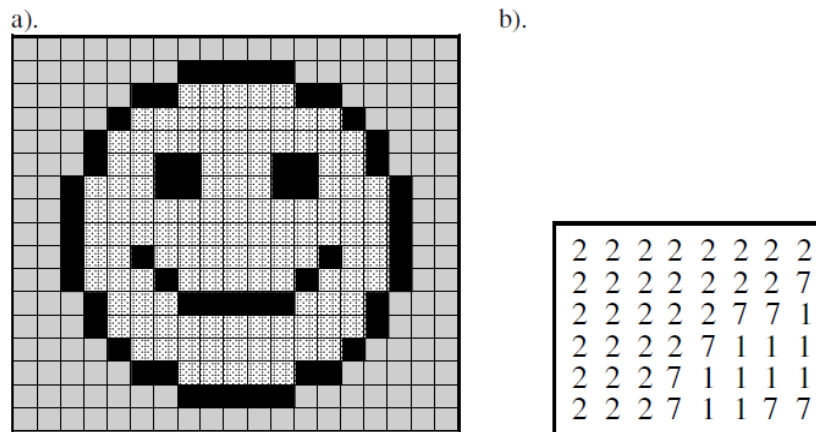


Figure 1.5 A simple figure represented as a bitmap.

How are raster images created?

The three principal sources are:

1. Hand designed images.

A designer figures out what values are needed for each cell, and types them into memory. Sometimes a paint program can be used to help automate this: the designer can draw and manipulate various graphical shapes, viewing what has been made so far. When satisfied, the designer stores the result in a file.

2. Computed Images.

An algorithm is used to “render” a scene, which might be modeled abstractly in computer memory. As a simple example, a scene might consist of a single yellow smooth sphere illuminated by a light source that emanates orange light.

3. Scanned images.

A photograph or television image can be digitized as described above. In effect a grid is placed over the original image, and at each grid point the digitizer reads into memory the “closest” color in its repertoire. The bitmap is then stored in a file for later use.