Higher Technological Institute
Computer Science Department

Computer Graphics

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Lecture One

Course Outlines

- Introduction to Computer Graphics .

- Overview of Graphics systems .

- Methods for producing basic picture components such as lines, circles, and polygons.

- Algorithms for performing geometric transformations such as rotation and scaling.

- Procedures for displaying views of two dimensional and three-dimensional scenes.
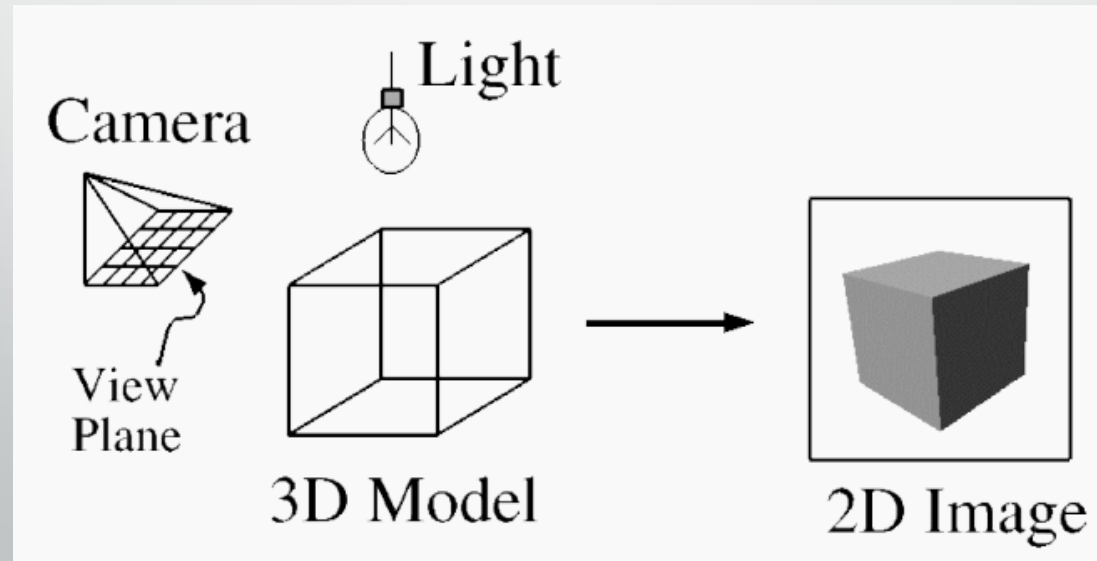
Textbook

"Computer Graphics with OpenGL" , Third edition , Hearn - Baker

Introduction to Computer Graphics

What is computer graphics?

"Computer graphics is concerned with producing images and animations"

- Imaging = *representing 2D images*

- Modeling = *representing 3D objects*

- Rendering = *constructing 2D images from 3D models*

- Animation = *simulating changes over time*

Applications

- Entertainment
- Computer-aided Design
- Scientific Visualization
- Training
- Education
- e-Commerce
- Computer Art
- Image Processing

Entertainment

Geri's Game
(Pixar Animation Studios)

Jurasic Park
(Industrial, Light, & Magic)

Quake
(Id Software)

Computer-aided Design

Gear Shaft Design
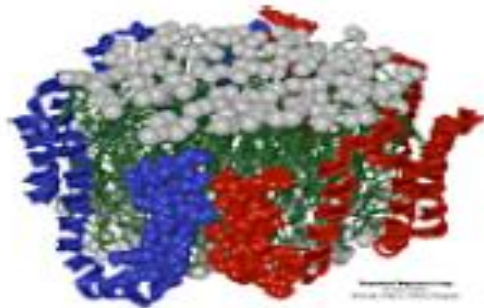(Intergraph Corporation)

Los Angeles Airport
(Bill Jepson, UCLA)

Boeing 777 Airplane
(Boeing Corporation)

Scientific Visualization

Airflow Inside a Thunderstorm
(Bob Wilhelmson,
University of Illinois at Urbana-Champaign)

Apo A-1
(Theoretical Biophysics Group,
University of Illinois at Urbana-Champaign)

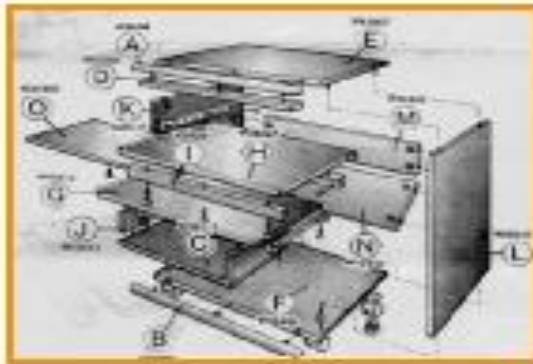Visible Human
(National Library of Medicine)

Training

Desk Assembly
(Silicon Graphics, Inc.)

Driving Simulation
(Evans & Sutherland)
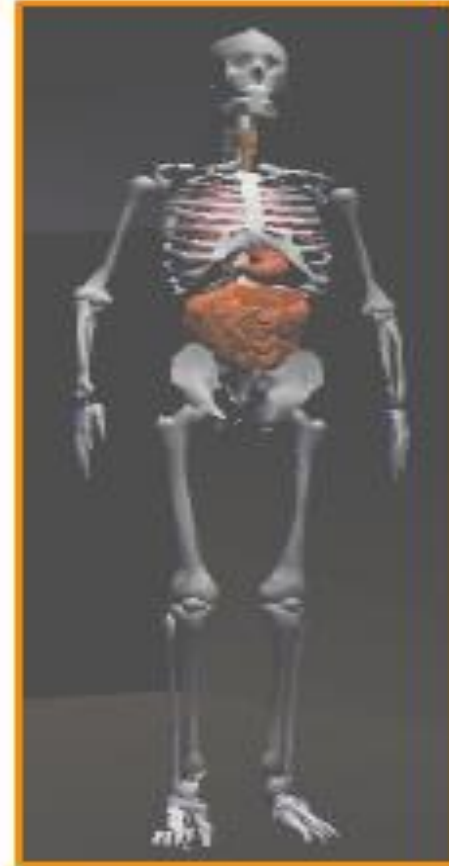
Flight Simulation
(NASA)

Education

Forum of Trajan
(Bill Jepson, UCLA)

Human Skeleton
(SGI)

e-Commerce

Virtual Phone Store
(Lucent Technologies)

Interactive Kitchen Planner
(Matsushita)

Computer Art

Blair Arch
(Marissa Range '98)

Image Processing

- Image processing is the modification of interpretation of existing pictures.
- Some IP applications:
  - ➢ improving image quality,
  - ➢ analyzing satellite photos of the earth and telescopic recordings of galactic star distributions.
  - ➢ Medical applications: picture enhancements in tomography, simulations of surgical operations, Ultrasonic and nuclear medical scanners.
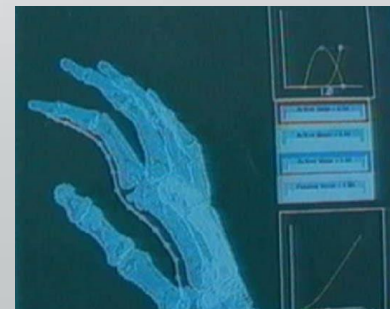
A Survey of Computer Graphics

Graphical User Interfaces (GUI)

 The major components of a graphical interface are a window manager, menus, and icons.

GUI: is a form of user interface that allows users to interact with electronic devices through graphical icons and audio indicator such as primary notation, instead of text-based user interfaces, typed command labels or text navigation

Overview of Graphics systems

We explore the basic features:

- Graphics hardware components.
  - Video display devices.
  - Input devices.
- Graphics software package.

Video Display Devices
1- Cathode Ray Tube (CRT)

➢ **Cathode Ray Tube (CRT)** A beam of electrons (cathode rays), emitted by an electron gun, passes through focusing and deflection systems that direct the beam toward specified positions on the phosphor-coated screen.

➢ The phosphor then emits a small spot of light at each position contacted by the electron beam.

➢ The most common method now employed for maintaining phosphor glow is to redraw the picture repeatedly by quickly directing the electron beam back over the same screen points.

تعتمد أنبوبة الكاثود في عملها على الظاهرة الفيزيائية وهي أن مادة الفسفور تشع ضوء إذا تم قصفها بسيل من الالكترونات والتي تمتلك السرعة والجهد الكافيين لتحفيز الكترونات مادة الفسفور وإعطائها الطاقة اللازمة لكي تنطلق وتتحرر من حزمة التكافؤ إلى حزمة الطاقة الأعلى، وأثناء عملية الانطلاق إلى حزمة أعلى فإنها تطلق مجموعة من الفوتونات والتي تمثل الضوء المنبعث.

Components:
1- Electron Gun
- Heating Element
- Cathode
- Control Grid
- Acceleration Anode
- Focusing Grid

2- Deflection Coils

Cathode Ray Tube (CRT)
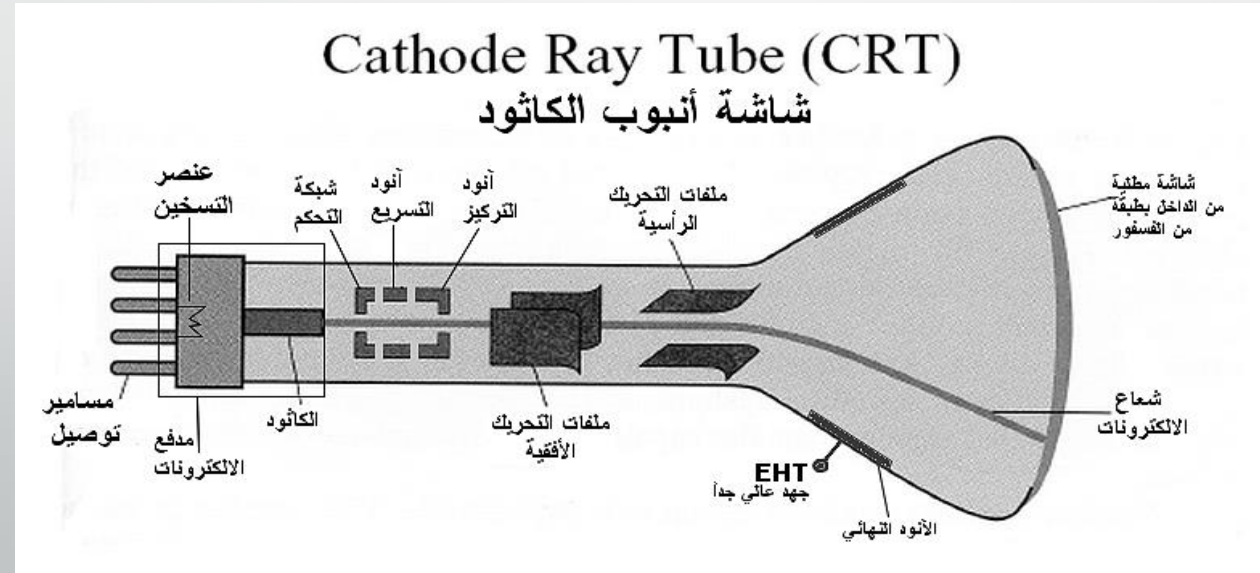
2- Color CRT MONITOR

➢ A CRT monitor displays color pictures by using a combination of phosphors that emit different-colored light.

➢ The emitted light from the different phosphors merges to form a single perceived color, which depends on the particular set of phosphors that have been excited.

https://www.youtube.com/watch?v=cwkuCgYI91w

Electron Guns

B
G
R

Selection of Shadow Mask

Red
Green Blue

Magnified Phosphor-Dot Triangle

Screen

19
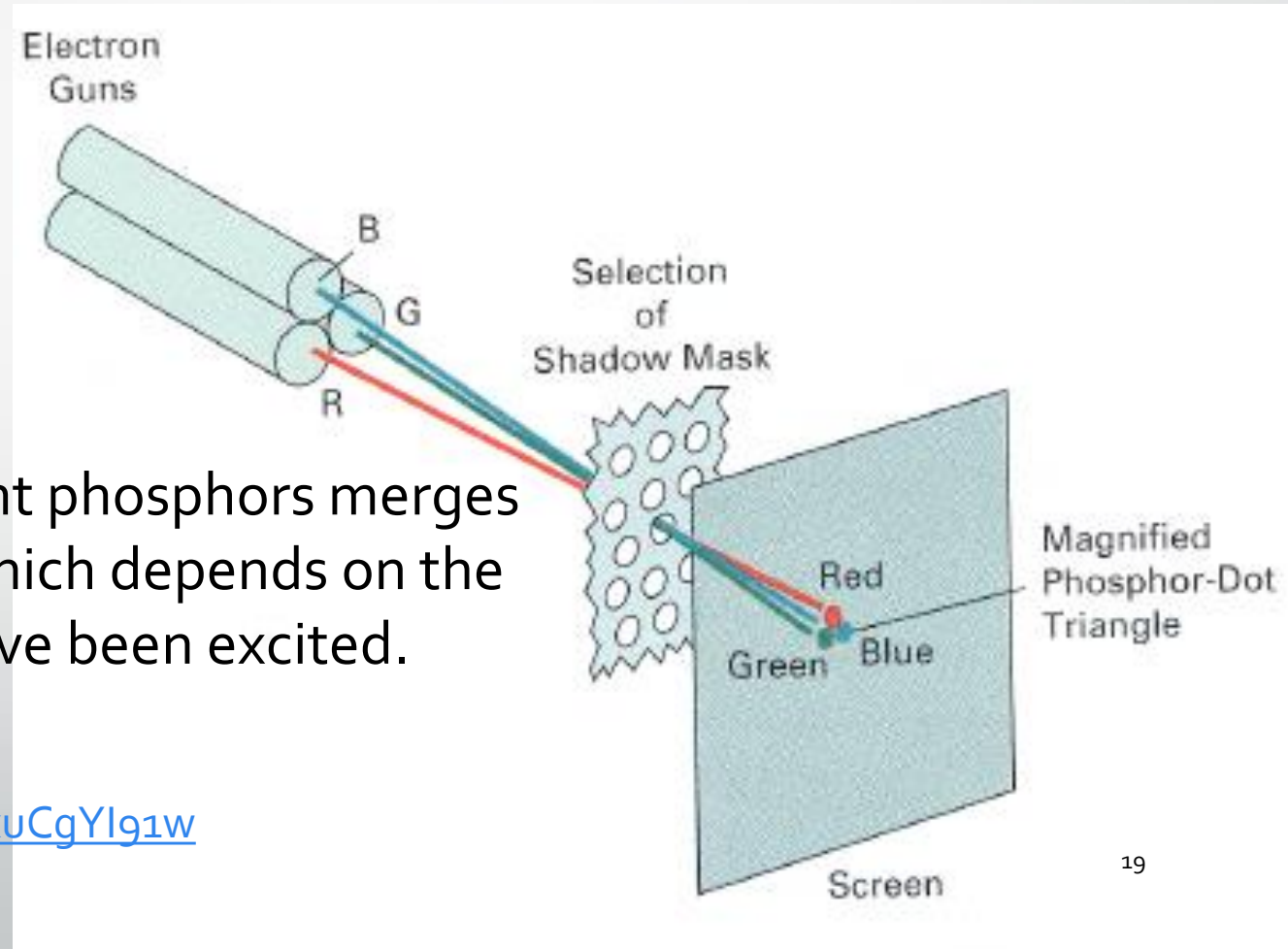
Flat-Panel Displays

➢ The term flat-panel display refers to a class of video devices that have reduced volume, weight, and power requirements compared to a CRT.

➢ Some additional uses for flat-panel displays are as small TV monitors, calculator screens, pocket video-game screens, laptop computer screens, armrest movie-viewing stations on airlines, advertisement boards in elevator.

➢ We can separate flat-panel displays into two categories: emissive displays and non-emissive displays.

Flat-Panel Displays

➢ The emissive displays (or emitters) are devices that convert electrical energy into light. Plasma panels, thin-film electroluminescent displays, and light-emitting diodes are examples of emissive displays.

➢ Non-emissive displays (or non-emitters) use optical effects to convert sunlight or light from some other source into graphics patterns. The most important example of a non-emissive flat-panel display is a liquid-crystal device LCD screen.

Input Devices

Keyboard

Mouse

Joysticks

Image scanners

Touch panels

Light pens

Voice System

Graphics software

- ***Special purpose package***

    Examples of such applications include artist's painting programs

- ***General programming packages***

    Provides a library of graphics functions that can be used in a programming language such as C, C++ , open GL.

Graphics Functions

- Graphics output Primitives.

- Attributes Graphics Primitives.

- Geometric transformations.

- Viewing transformations.

- Many other operation.

OpenGL

➢ OpenGL is a software interface to graphics hardware.

➢ OpenGL is designed as hardware-independent interface to be implemented on many different hardware platforms.

➢ OpenGL doesn't provide high-level commands for describing models of three-dimensional objects. Such commands might allow you to specify relatively complicated shapes such as automobiles, parts of the body, airplanes, or molecules.

➢ With OpenGL, you must build up your desired model from a small set of geometric primitive -points, lines, and polygons.

http://www.openGL.org.

https://www.opengl.org/sdk/docs/man2/

OpenGl programming Guide Book:

http://www.glprogramming.com/red/

Download OpenGL

How to get OpenGL working in Visual Studios 2013

https://www.youtube.com/watch?v=3IjxgvZq9a0

OpenGl, GLU and GLUT

- OpenGL: basic functions.

- GLU: OpenGl Utility library.

- GLUT: OpenGL Utility toolkit library.

GLU and GLUT: Handy functions for viewing and geometry.

Basic OpenGL Syntax

Function names in the OpenGL basic library

glBegin,   glClear,   glCopyPixel

Certain functions : for instance , a parameter name

GL_2D,   GL_RGB, GL_POLYGON

Data type:

GLbyte, GLint,   GLfloat, Glboolean

Related libraries

 The OpenGL Utility (GLU): all GLU function names start with glu

Header files
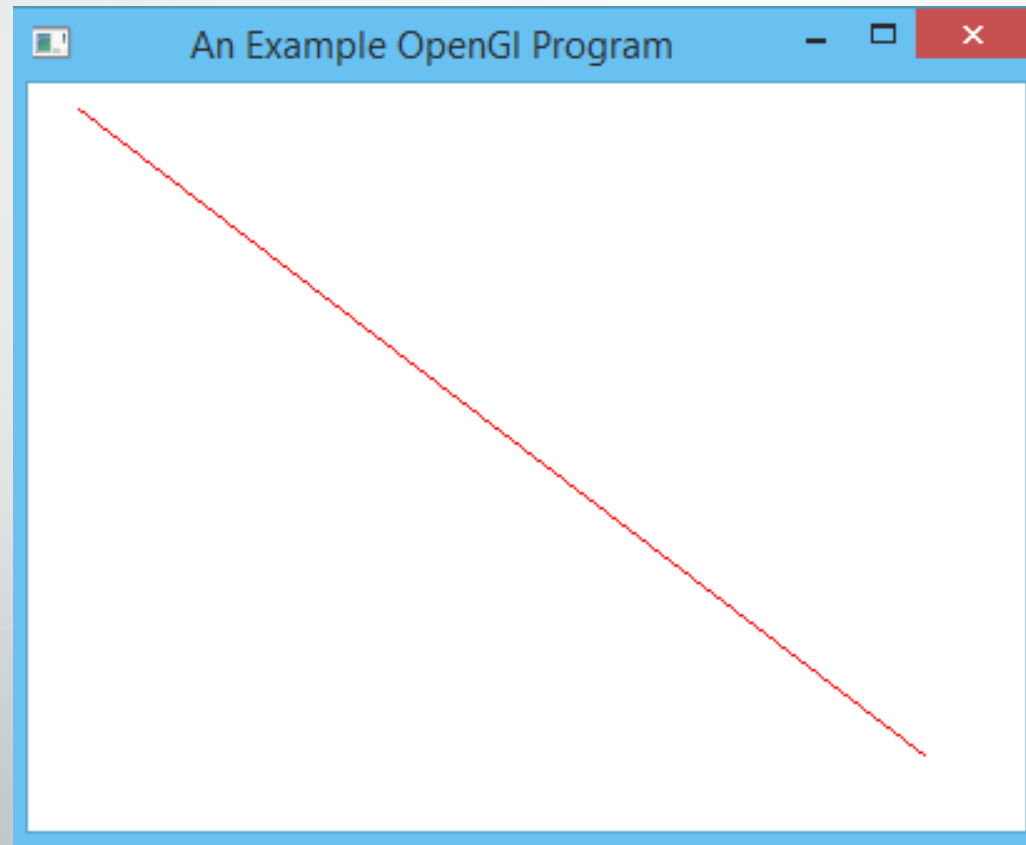
 #include<windows.h>

 #include<GL/gl.h>

 #include<GL/glu.h>

If we used OpenGL Utility Toolkit(GLUT) we can replace the header files with

 #include <GL/GLUT.h>

Example

The display windows and line segment such as following Figure :

```cpp
#include <Windows.h>
#include <GL\glew.h>
#include <GL\freeglut.h>
#include <iostream>
#include <GL/glut.h> // (or others, depending on the system in use)
void init (void){
glClearColor (1.0, 1.0, 1.0, 0.0); // Set display-window color to white.
glMatrixMode (GL_PROJECTION); // Set projection parameters.
gluOrtho2D (0.0, 200.0, 0.0, 150.0);}
void lineSegment (void){
glClear (GL_COLOR_BUFFER_BIT); // Clear display window.
glColor3f (1.0, 0.0, 0.0); // Set line segment color to red.
glBegin (GL_LINES);
glVertex2i (180, 15); // Specify line-segment geometry.
glVertex2i (10, 145);
glEnd ( );
glFlush ( ); // Process all OpenGL routines as quickly as possible.}
void main (int argc, char** argv){
glutInit (&argc, argv); // Initialize GLUT.
glutInitDisplayMode (GLUT_SINGLE|GLUT_RGB); // Set display mode.
glutInitWindowPosition (50, 100); // Set top-left display-window position.
glutInitWindowSize (400, 300); // Set display-window width and height.
glutCreateWindow ("An Example OpenGL Program"); // Create display window.
init ( ); // Execute initialization procedure.
glutDisplayFunc (lineSegment); // Send graphics to display window.
glutMainLoop ( ); // Display everything and wait.
}
```