

## **Introduction to Computer Graphics**

### Prerequisite

Knowledge in programming, data structures, algorithms, software engineering and basic algebra.

- to build on these topics
- in both informative and fun way.

## **Graphics Systems and Models**

### What is Computer Graphics?

All aspects of producing pictures/images using a computer (most of the times indistinguishable from photographs).

### Applications/Categories

1. Display of information
2. Design
3. Simulation and Animation
4. User Interfaces

#### 1. Display of info

Graphics, a medium to convey information among people seeing something that is more easily visualized.

#### 2. Design

e.g. engineering/architecture (CAD)  
an interactive process

#### 3. Simulation and Animation

e.g. training pilots (increase safety, lower costs)  
games and educational software, robots  
animations for T.V.(entire movies), motion-picture, advertising  
V.R. (headset, force-sensing gloves, sound).

#### 4. User Interfaces

Windows, icons, menus, pointing devices (mouse)  
X-Windows, Microsoft Windows, Macintosh – same interface tools.

### A Graphics System

Processor, Memory, Frame Buffer, Output devices and Input devices.

Raster or pixel of picture elements – Storage: Frame Buffer.

The depth of the frame buffer: bits used for each pixel determines properties such as how many colours.

e.g. 1-bit deep frame buffer – 2 colours

8-bit deep frame buffer –  $2^8$  (=256) colours

>24-bit deep frame buffer – a full-colour system

True-colour or RGB-colour systems

Resolution: Number of pixels in the frame buffer, determines the detail that you can see.

### Output devices

C.R.T. (cathode ray tube) - refreshed at least 50 times per second

L.C.D.s (liquid-crystal displays)

### Input devices

Keyboard, mouse, joystick, data tablet – pointing devices

### Process outline

1. Start with 2D and then progress to 3D
2. Mathematical objects – 2D
3. 3D
4. Lighting, shading and properties of materials

We live in a world of 3D objects.

2 basic entities: objects (a set of vertices) and viewers (forms the image of the object).

Light – the visible spectrum (wavelengths)

e.g. laser – emits light at a single wavelength

lamp – emits energy over a range of wavelengths

### Ray tracing

- an image-formation technique
- to simulate physical effects
- not well suited for fast computation

The Human Visual System – extremely complex

The Pinhole Camera

The Synthetic-Camera Model

The Programmer's Interface

API – Application Programmer's Interface (interface of functions in a graphics library)

- The Pen-Plotter Model

### 3D APIs

The synthetic-camera model is the basis for a number of popular APIs including OpenGL, PHIGS, Direct3D, VRML, and JAVA-3D.

We need functions in the API to specify

- objects – defined by a set of vertices: line segments, rectangles, polygons
- viewer – position, orientation, focal length, film plane
- light sources – location, strength, colour and directionality
- material properties – characteristics or attributes of the objects