

COMPUTER GRAPHICS

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Learning Objectives

- The learning objectives of this chapter are to study and understand the evolution of computer graphics. What is computer graphic? What is the advancement in computer graphics with time and technological innovations? What is needed in computer graphics? What are the applications of computer graphics in industry?

Introduction

- With the advancement of technology, usage of computer has become a necessity in almost every field. But how this is useful in field like engineering, medical. Normally in engineering field design and modeling is an important issue. Also in medical field, digital diagnosis (like X-Ray, MRI, and NMR) is simply the digital image processing. So in both fields we use a term Computer graphics. Computer graphics means creation, storage and manipulation of models and images. Here we are using a term 'model'. This word 'model' has diverse meanings and aspects like physical, mathematical, artistic, biological and even conceptual (abstract) structures.(source Wikipedia). Perhaps, there is not a complete definition of computer graphics. But we can define it as a combination of skill, knowledge, art as well as innovation. It is creativity, a thought process, tricks and techniques which designer innovates or learns through experience and receives from an experienced designer

History of computer graphics

- The invention of geometry was the basis of graphics concepts. The invention of geometry was done by Euclid during 300 - 250 BC.
- Then the work of various architects and sculptors gave a new three dimensional turn to graphics by innovators like Filippo Brunelleschi and Goldsmith during 1377 – 1446.
- During (1596-1650) Rene Descartes developed analytic geometry, in particular coordinate systems, which explained the concept of location and shape of objects in space.
- With the invention of matrix during 1814- 1897 by Joseph Sylvester a new definition was added to graphics. A lot of graphical images could now be created with matrices.

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- A fundamental type of curve i.e. Spline curve discovered by I. Schoenberg added another milestone to the journey of graphics.
- John William Mauchly and J. Presper Mauchly, in late 1930's invented ENIAC Computer due to which the field of graphics got its launch pad.
- The term computer graphics was introduced in 1980's and field matured during early 90's.
- Computer graphics were manifested beautifully a movies like *Flight of the Intruder, Jurassic Park*. Where organization like *Rhythm and Hues studio* created realistic effect with their own *graphics software*.
- Then Degraf and Wahram created a first graphics ridefilm called *Hanna Barbera*. It was fully 3D film for Universal Studio Florida.

Application of computer Graphics

- **In Medical field:** Medical profession is meant to save the life and cure the patient. Computer graphics play important role in the field of medicine and diagnosis. We can proudly say that without the intervention of computer graphics in medical field, the advancement in medical line was impossible. Computer graphics is helping the medical profession by digital imaging diagnosis, that is with the help of special purpose computer and software diagnosis are able to take the 3D image of the different part of the internal organs that helps the doctors to diagnose the exact diseases and reason of those diseases. With the help of Digital drug designing new medicine designed and modeled on computer. Wet lab experiments are conducted by the research and development team of the pharmaceutical companies to design and test the new medicine for disease. There is wide range of computer graphics application for medical purpose.

- **Computer graphics in Simulation:** Simulation is a process to create the environment and infrastructure similar to the original system. “Simula” means Replica. Basically, simulation is a science to generate a replica of original system for testing and training. For example, during the training of astronauts a simulation model of space is created in a room where no gravity and no atmospheric pressure. The zero gravity room is called space simulation model. Similarly to test the expensive experiments digital simulation model is created in computer graphics and that experiment can be conducted again and again on computer without any cost.

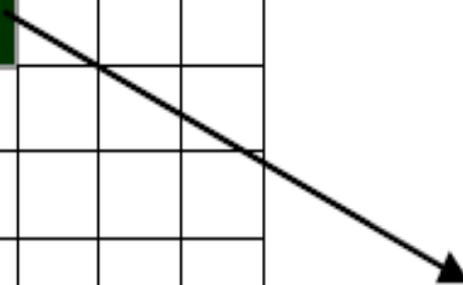
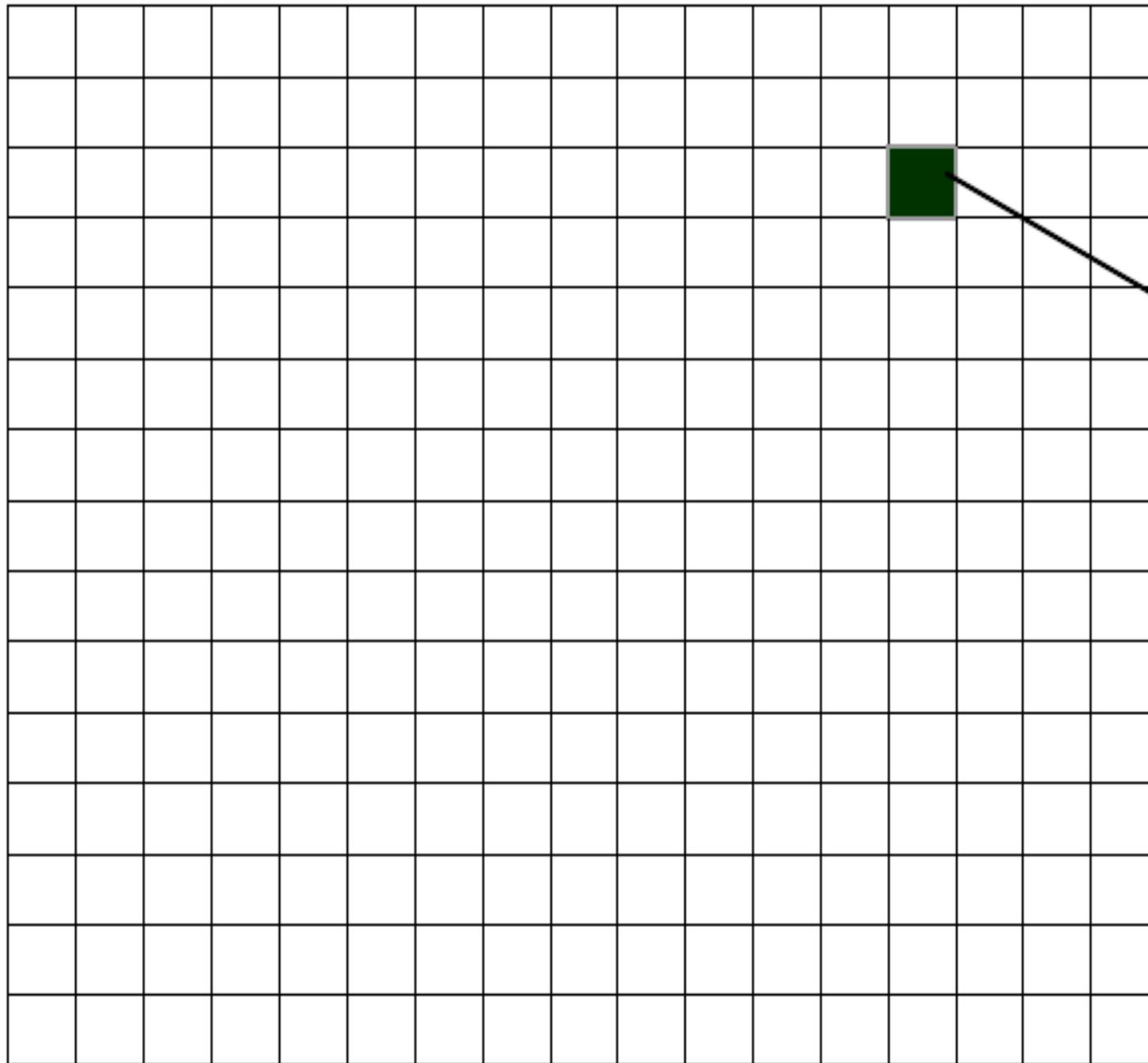
- **In Field of Engineering** : In engineering, field belongs to different fields like designing and modeling is the main task or issue for engineers. Engineers may be architecture, mechanical, Geological and many others. Every engineer has to prepare design or model for example architectures design the map or model of building, Mechanical engineers design the model of cars or machines. For all of them, wide range of graphics application available in the market for computer aided designing. Computer graphics has a dramatic impact on the design process. Today, most mechanical and electronic designs are executed entirely on computer. Increasingly, architectural and product designs are also migrating to the computer. CAD designs also play a key role in a wide range of processes.

- **Graphical User Interfaces (GUIs):** GUI i.e. Graphical User Interface, It is interface humans and the machine but in a language and imagery which is very friendly to human so that even illiterate can operate on computer, it helps in improving and simplifying computing every day. Computer graphics is an integral part of everyday computing. While working on computer we use terms Folder, icon, taskbar, radio button, textbox, checkbox, all are elements of GUI. Elements like windows, cursors, menus etc are the essential part of graphical user interface. And due to GUI a layman can operate on computer. A 5 year child who is unable to read and write English can operate on computer and mobile with help of graphical images i.e. GUI. So many thanks to Computer graphics, because it has made this powerful device accessible to even illiterate person.

- **Entertainment:** The invention of computer graphics was done by the persons from entertainment industry. If you can imagine it, you can create it with the help of computer graphics. Motion pictures, Music videos, TV shows, Computer games all are ineffective and tasteless without computer graphics. Computer graphics has become the important part of the entertainment industry. Animation movies are possible due to computer graphics. Cartoon movies are making their deep impact on our new generation. These cartoon movies are born from the womb of computer graphics.

Principle of Computer graphics

- **Pixel** :Pixel is a tiny particle of the screen. Pixel is the basic element of a digital image. Let us talk about our output screen i.e. monitor, the resolution of monitor is measured as number of pixel in the screen. Normally we use a term pixel density that is number of pixel per inch of the screen. Higher the pixel density of a display device means higher the resolution of that particular device. Higher the resolution means better picture quality of the display device. The screen of display devices consists of pixel matrix i.e. rows and columns of pixels. The ordering of the pixel matrix varies with the type of devices. We can visualize our display device as a grid of two dimensional grids of pixels. Where each pixel is shaped as a square dot and number of square dot on per inch of the screen is called pixel density of the screen.

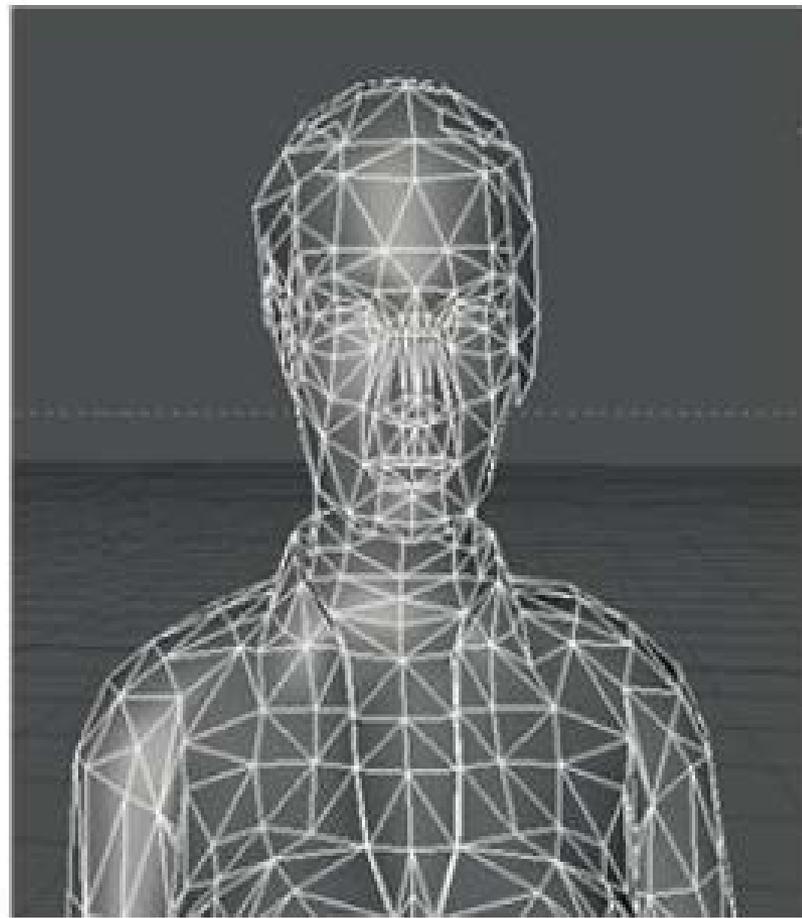


pixel

- This tiny particle on the screen is responsible to form the image on the display devices. The clarity of an image is depends on the resolution of image which is number of pixels per inch of the image. Higher the number of pixels, higher the image quality. Intact Color of the image depends on the intensity of pixels. Intensity of pixel is defined by three Standard colors i.e. RED, GREEN and BLUE. The different intensities of these three color may generate different colors for a pixel. So Color image is basically the data of intensities of RGB color of each pixel on the image. Higher the pixel in the image higher will be the data and size of image file and better will be the resolution or image quality.

- **Graphics** : Graphics can be defined as a visual representation of and a image on a surface which may be paper, floor, wall or a leaf or a computer screen. Graphics can be art work painted by the painter on the chart. It can be a map designed by the architect on the paper or it can be a surgical plan made by the surgeon on paper before operation. Graphics are often a combination of text and pictures, figures or diagrams. Graphic design may consist of intended creation/arrangement of typography alone or typography with illustrations for example web page or website, poster, brochure , Flex ,Pamphlets, title page of the books or magazines. The objective and theme of the design is defined before designing. A good design communicates the clarity and effectiveness of the design.

- **Rendering:** Rendering is a process of generating 2D images from 3D model. Basically 3D models are collectively called scene file. By means of computer software or program rendering can be easily done. The input is the scene file and output of this software is the 2D image. Scene file contains the information about the geometry of the objects along with texturing, lighting and shading information of the objects. For complex rendering calculations, a special hardware device called graphical pipeline unit is attached with CPU. Graphical Pipeline Unit is a special hardware unit which assists the CPU in performing complex rendering calculations



3D RENDER

- **Projection** : Projection is the methodology of transforming the 3D objects on 2D plane. Projection plays important role in computer graphics. Because our computer screen is 2D and to display the 3D object on 2D screen the projection is used. Projection is of two types are:

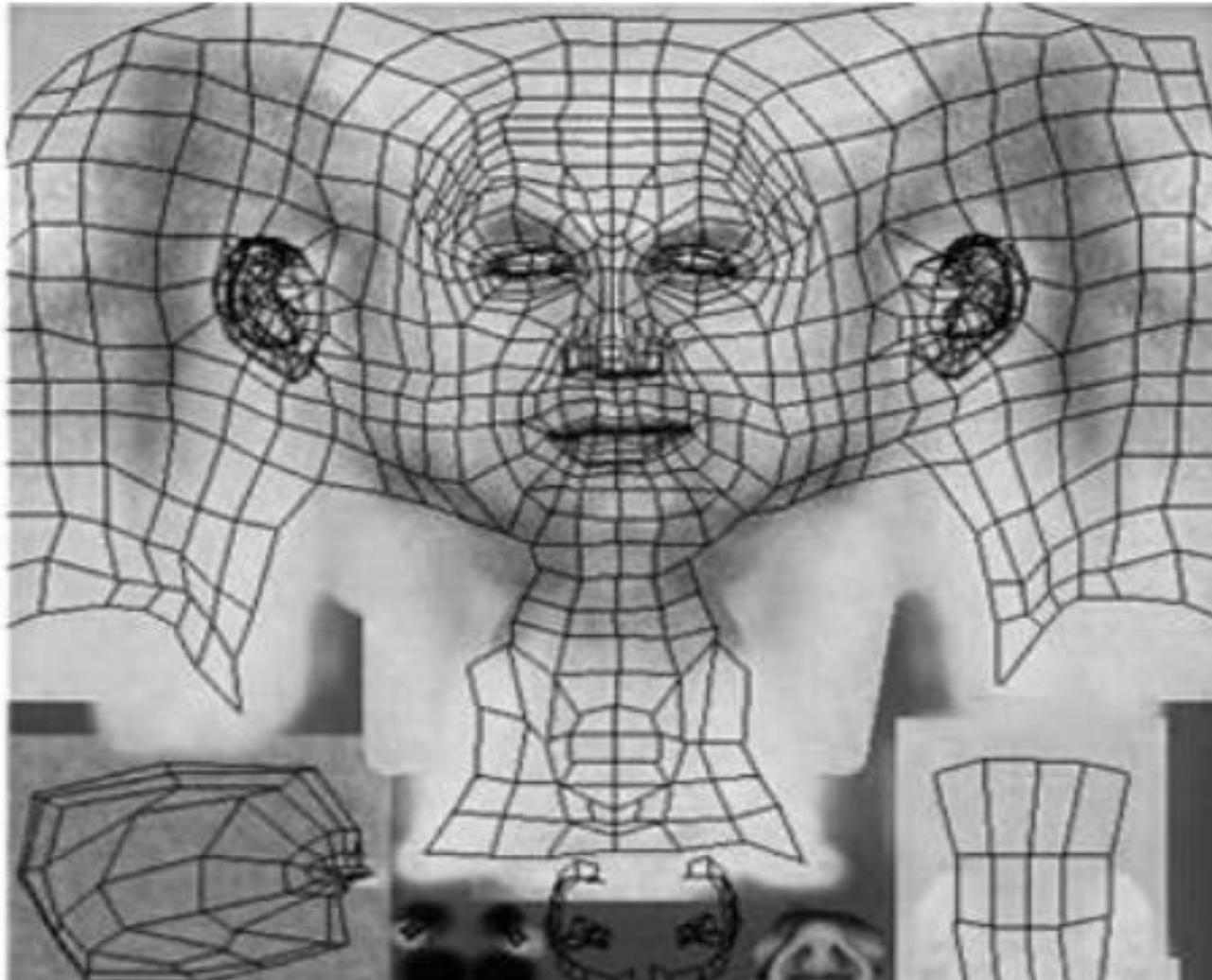
Parallel projection: In Parallel projection coordinate position are transformed to the view plane along parallel lines.

Perspective Projection: Object Position, is transformed to the plane along lines that converge to a point called center of projection.

Ray Tracing : This is a technique to provide the realism in a scene. While designing, the motive of a designer is always to put life and realism in design. In the past, design were created with ink and watercolors. It was really hard and difficult for the designer to produce realistic illumination effect for realism in design. But with computers we have CAD programs for computer aided designing. But most of the CAD programs are unable to produce realism in design. Basically, to generate the illumination effect in design, means to concentrate on every detail like light, shadows, blinking , shining etc. of the object. Ray tracing is a technique to calculate the light intensity of each pixel which is responsible to define the light and shadow of the pixel. With the invention of this technique the dreams about realism comes true.

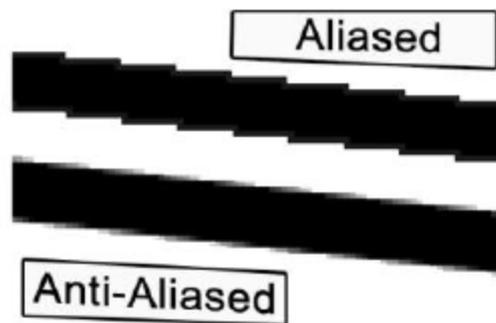
Shading: Shading refers to the level of darkness. It is a process used in drawings to describe the darker lighter areas of the design. This methodology is again used for detailing in the design. In computer designing, various tools and plug in are available which we can embed in to our designing software for shading purpose.

Texture Mapping : Is a technique to add color or other surface detail like glossiness, reflectivity or transparency to the computer design. In 1974, Edwin Catmull had introduced this technique in 3D computer graphics. Texture mapping is applied on the surface of the shape. With the advancement, this technique has grown in further subtypes like procedural mapping and bitmap mapping.



TEXTURE MAP

Anti-Aliasing: In raster display devices, like Cathode Ray tube and liquid Crystal Display, there is problem of aliasing. Of course, I shall first introduce you to the new term Raster display device. These are devices which display the images on pixels. These are pixel based devices. However there is a problem of aliasing in raster devices. Aliasing is noise or distortion of the image along the edges and boundaries or simply, we can say that aliasing affects the sharpness of the image and damage the quality of image. So, Anti aliasing is a technique to eliminate this effect and improve the image quality in raster devices. This technique is implemented in term of algorithm and software and it has become an essential tool of the graphics software.



Volume Rendering: This technique has great importance in scientific visualization (A phenomena in various branches of science like Engineering, Biology, Medical, Meteorological etc. to detail the image of 3D objects with by illumination effects e.g. X-ray, CT Scan, MRI etc.). This term is related to computer graphics. In scientific visualization, motive is to find the detailing any hidden object which can not been seen by naked eyes. By this technique, illumination effect is generated to define the abnormalities in the 3D image while displaying it on the 2D surface. Scientists needs this detailing for further research and development.

- **3D Modeling** :In computer graphics, 3D modeling is the phenomena to generate, display the 3D image on display device. It is the method of developing a mathematical representation of any three dimensional surface of object with special software. In modeling, geometric and mathematical data is generated for any 3D object and stored in computer memory. Modeling software uses this data to generate the 3D model. Further, this data is used by other tools for 3D rendering, texturing and volume rendering etc to create the realism in that model. By mathematical data we mean geometrical description of the three dimensional objects like line, circle, polygon, curve and surface etc which are the basic elements to define the objects in 3D scene.



3D MODEL

Summary

Computer graphics has a major role in every field science, entertainment, engineering etc. Computer graphics is playing immense role in almost every industry. Various techniques of computer graphics are being used for research and development and even in life saving techniques like diseases diagnosis etc. Further, these techniques are of immense importance in converting 3D scene detailing on to a planar 2D surface for better understanding. Examples include 3D images of internal organs of the body can be shown on display screen or printed on paper. Similarly, it is used in metallurgy, to find the underground minerals like coal, petroleum, iron, gold or diamond etc. without actual digging of earth. This saves a lot of time labor and resources. Hat off to Computer graphics.