iJRASET
International Journal For Research in
Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 2 **Issue:** X **Month of publication:** October 2014

**DOI:**

ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology(IJRASET)

# Introduction to Computer Graphics

Kamal Kathuria[1], Manjeet Saini[2], Bharat Malhotra[3]

*Department of Computer Science and Engineering*

*Dronacharya College of Engineering, Khentawas, Farrukh Nagar – 123506*

*Gurgaon, Haryana*

***Abstract:-* Computer graphics is a field which studies methods for digitally synthesizing and manipulating visual content. Computer Graphics is when pictures created using computers whereas the representation of image or data by a computer specifically with help of specialized graphic hardware and software. The term computer graphics has been used to describe "almost everything on computer that is not text or sound only". Typically, the term computer graphics has several different things:**

- ***The representation and alteration of image data by a computer.***
- ***Use of various technologies to create and manipulate images***
- ***It can be sub-field of computer science which studies methods for digitally synthesizing and manipulating visual content.***

***Computer generated imagery can be categorized into several different types: Two dimensional (2D), three dimensional (3D), and animated graphics.***

***Keywords:-* Two dimension, three dimensions, Graphics, image, Vector image, Raster image, mesh-modeling, mesh-subdivision, RGB, Pixel, Rendering, Mapping, and Tracing, Animation, Rendering, Topology, Imaging, Shading, 2D-modeling, Vector Graphics, 3D-art.**

## I. INTRODUCTION

Computer graphics are visual representations of data displayed on a monitor made on a computer. Computer graphics can be a series of images most often called videos or a single image. Computer graphics studies the manipulation of visual and geometric information using computational techniques. It focuses on the mathematical and computational foundations of image generation and processing rather than purely aesthetic issues. One of the first displays of computer animation was Future world in 1976, which included an animation of a human face and hand — produced by Ed Catmull and Fred Parke at the University of Utah. Swedish inventor Haakon Lans applied for the first patent on color graphics in 1979.

Computer graphics is further sub-classified into several fields:-

1. **Geometry**: studies ways to represent and process surfaces
2. **Animation**: studies with ways to represent and manipulate motion
3. **Rendering**: studies algorithms to reproduce light transport
4. **Imaging:** studies image acquisition or image editing
5. **Topology**: studies the behavior of spaces and surfaces.

**Geometry:-**

The subfield of geometry studies the representation of three-dimensional objects in a discrete digital setting. Because the appearance of an object depends largely on its exterior, boundary representations are most commonly used. Two dimensional surfaces are a good representation for most objects, though they may be non-manifold. Since surfaces are not finite, discrete digital approximations are used. Polygonal meshes are by far the most common representation, although point-based representations have become more popular recently. These representations are Lagrangian, meaning the spatial locations of the samples are independent. Recently, Euler Ian surface descriptions such as level sets have been developed into a useful representation for deforming surfaces which undergo many topological changes.

**Subfields:-**

- Implicit surface modeling – Which is an older subfield which examines the use of algebraic surfaces, constructive solid geometry, etc., for surface representation.
- Digital geometry processing – It is a surface reconstruction, simplification, fairing, mesh repair, parameterization,

remising, mesh generation, surface compression, and surface editing all fall under this heading.

- Discrete differential geometry – It is a nascent field which defines geometric quantities for the discrete surfaces used in computer graphics.
- Point-based graphics – This is a recent field which focuses on points as the fundamental representation of surfaces.
- Out-of-core mesh processing –Which is another recent field which focuses on mesh datasets that do not fit in main memory.

**1. Animation:-**

The subfield of animation studies descriptions for surfaces that move or deform over time. Most work in this field has focused on parametric and data-driven models, but recently physical simulation has become more popular as computers have become more powerful computationally.

**Subfields:-**

- Performance capture
- Character animation
- Physical simulation E.g. cloth modeling, animation of fluid dynamics, etc.

**2. Rendering:-**

It generates images from a model. This may simulate light transport to create realistic images or it may create images that have a particular artistic style in non-photorealistic rendering. The two basic operations in realistic rendering are transport that is how much light passes from one place to another and scattering i.e. how surfaces interact with light).

**Transport:-**

It describes how illumination in a scene gets from one place to another. Visibility is a major component of light transport.

**Scattering:-**

Models of scattering and shading are used to describe the appearance of a surface. In graphics these problems are studied within the context of rendering since they can substantially affect the design of rendering algorithms. Shading can be broken down into two orthogonal issues, which often studied independently:

1. scattering – It states how light interacts with the surface at a given point
2. shading - how material properties vary across the surface

The former problem refers to scattering i.e., the relationship between incoming and outgoing illumination at a given point. Descriptions of it are usually given in terms of a bidirectional scattering distribution function. The latter issue addresses how different types of scattering are distributed across the surface i.e., which scattering function applies where. Descriptions of this kind are typically expressed with a program called a shader. Note that there is some confusion since the word "shader" is sometimes used for programs that describe local geometric variation.

**Other subfields:-**

- physically based rendering - concerned with generating images according to the laws of geometric optics
- real time rendering - focuses on rendering for interactive applications, typically using specialized hardware like GPUs
- non-photorealistic rendering
- relighting - recent area concerned with quickly re-rendering scenes

## II. CONCEPTS AND PRINCIPLES

An image is an artifact that records or stores visual perception. Digital images include both vector images and raster images, but raster images are more commonly used.

Vector images consists use of geometrical primitives such as points, lines, curves, and shapes or polygons, all of which are based on mathematical expressions to represent images in computer graphics.

**1. Pixel**

In digital imaging, a pixel or picture element is a single point in a raster image. Pixels are placed on a regular 2-dimensional grid, and are often represented using dots or squares. Each pixel is a sample of an original image, where more samples typically provide a more accurate representation of the original. The intensity of each pixel is variable; in color systems, each pixel has typically three components such as red, green, and blue that is they uses RGB color model.

**2. Graphics:-**

Graphics are visual presentations on a surface, such as a computer screen. Examples are photographs, drawing, graphics designs, maps, engineering drawings, or other images. Graphics often combine text and illustration. Graphic design may consist of the selection, creation, or arrangement of typography alone, as in a brochure, flier, poster, web site, or book without any other element.

**3. Rendering:-**

Rendering is generating a 3D model by means of computer programs. A scene file contains objects in a strictly defined language or data structure; it would contain geometry, viewpoint, texture, lighting, and shading information as a description of the virtual scene. The data contained in the scene file is then passed to a rendering program to be processed and output to a digital image or raster graphics image file. The rendering program is usually built into the computer graphics software, though others are available as plug-ins or entirely separate programs. The term "rendering" may be by analogy with an "artist's rendering" of a scene. Though the technical details of rendering methods vary, the general challenges to overcome in producing a 2D image from a 3D representation stored in a scene file are outlined as the graphics pipeline along a rendering device, such as a GPU. A GPU is a device able to assist the CPU in calculations. If a scene is to look relatively realistic and predictable under virtual lighting, the rendering software should solve the rendering equation. The rendering equation does not account for all lighting phenomena, but is a general lighting model for computer-generated imagery. 'Rendering' is also used to describe the process of calculating effects in a video editing file to produce final video output.

**4. 3D projection:-**

3D projection is a method of mapping three dimensional points to a two dimensional plane. As most current methods for displaying graphical data are based on planar two dimensional media the use of this type of projection is widespread, especially in computer graphics, engineering and drafting.

**5. Ray tracing:-**

Ray tracing is a technique for generating an image by tracing the path of light through pixels in an image plane. The technique is capable of producing a very high degree of photorealism; usually higher than that of typical scan line rendering methods, but at a greater computational cost.

**6. Shading:-**

Shading refers to depicting depth in 3D models or illustrations by varying levels of darkness. It is a process used in drawing for depicting levels of darkness on paper by applying media more densely or with a darker shade for darker areas, and less densely or with a lighter shade for lighter areas. There are various techniques of shading including cross hatching where perpendicular lines of varying closeness are drawn in a grid pattern to shade an area. The closer the lines are together, the darker the area appears. Likewise, the farther apart the lines are, the lighter the area appears.

**7. Texture mapping:-**

Texture mapping is a method for adding detail, surface texture, or color to a computer-generated graphic or 3D model. A texture map is applied or mapped to the surface of a shape, or polygon. This process is akin to applying patterned paper to a plain white box. Multi texturing is the use of more than one texture at a time on a polygon. Procedural textures (i.e.; created from adjusting parameters of an underlying algorithm that produces an output texture), and bitmap textures (i.e. created in an image editing application or imported from a digital camera) are, generally speaking, common methods of implementing texture definition on 3D models in computer graphics software, while intended placement of textures onto a model's surface often requires a technique known as UV mapping (arbitrary, manual layout of texture coordinates) for polygon surfaces, while NURBS surfaces have their own intrinsic parameterization used as texture coordinates.

**8. Anti-aliasing:-**

Rendering resolution-independent entities such as 3D models for viewing on a raster or pixel-based device such as a liquid-crystal display or CRT television inevitably causes aliasing artifacts mostly along geometric edges and the boundaries of texture details; these artifacts are informally called "jaggies".

Anti-aliasing methods rectify such problems, resulting in imagery more pleasing to the viewer, but can be somewhat computationally expensive. Various anti-aliasing algorithms (such as super sampling) are able to be employed, then customized for the most efficient rendering performance versus quality of the resultant imagery; a graphics artist should consider this trade-off if anti-aliasing methods are to be used. A pre-anti-aliased bitmap texture being displayed on a screen or screen location at a resolution different than the resolution of the texture itself (such as a textured model in the distance from the virtual camera) will exhibit aliasing artifacts, while any procedurally defined texture will always show aliasing artifacts as they are resolution-independent; techniques such as mip-mapping and texture filtering help to solve texture-related aliasing problems.

**9. Volume rendering:-**

Volume rendering is a technique used to display a 2D projection of a 3D discretely sampled data set. A typical 3D data set is a group of 2D slice images acquired by a CT or MRI scanner. Usually these are acquired in a regular pattern (e.g., one slice every millimeter) and usually have a regular number of image pixels in a regular pattern..

**10. 3D modeling:-**

3D modeling is the process of developing a mathematical, wireframe representation of any three-dimensional object, called a "3D model", via specialized software. Models may be created automatically or manually; the manual modeling process of preparing geometric data for 3D computer graphics is similar to plastic arts such as sculpting. 3D models may be created using multiple approaches: use of NURBS curves to generate accurate and smooth surface patches, polygonal mesh modeling (manipulation of faceted geometry), or polygonal mesh subdivision which is advanced tessellation of polygons, resulting in smooth surfaces similar to NURBS models. A 3D model can be displayed as a two-dimensional image through a process called 3D rendering, used in a computer simulation of physical phenomena, or animated directly for other purposes. The model can also be physically created using 3D Printing devices.

**Types of Image:-**

**1. Two-dimensional:-**

2D computer graphics are the computer-based generation of digital images mostly from models, such as digital image, and by techniques specific to them.

2D computer graphics are mainly used in applications that were originally developed upon traditional printing and drawing technologies. In those applications, the two-dimensional image is not just a representation of a real-world object, but also an independent artifact with added semantic value; two-dimensional models are therefore preferred, because they give more direct control of the image than 3D computer graphics, whose approach is more akin to photography than to typography.

**2. Pixel art:-**

A large form of digital art being pixel art is created via the use of raster graphics software, where images are edited on the pixel level. Graphics in most old or relatively limited computer and video games, graphing calculator games, and many mobile phone games are mostly pixel art.

**3. Vector graphics:-**

Vector graphics formats are complementary to raster graphics. Raster graphics is the representation of images as an array of pixels and is typically used for the representation of photographic images. Vector graphics consists in encoding information about shapes and colors that comprise the image, which would allow for more flexibility in rendering. There are instances when working with vector tools and formats is best practice whereas instances are when working with raster tools and formats is best practice.

**4. Three-dimensional:-**

3D graphics as compared to 2D graphics are graphics that uses a three-dimensional representation of geometric data. For the purpose of performance this is stored in computer. This includes images that may be for later display or for real time viewing.

International Journal for Research in Applied Science & Engineering Technology(IJRASET)

3D computer graphics rely on similar algorithms as 2D computer graphics do in the frame and raster graphics in the final rendered display. In computer graphics software, the distinction between 2D and 3D is occasionally blurred and 2D applications may use 3D techniques to achieve effects such as lighting, and primarily 3D may use 2D rendering techniques.

3D computer graphics are the same as 3D models. This model is contained within the graphical data file, apart from the rendering. There are differences that include the 3D model is the representation of any 3D object. Due to printing, 3D models are not only confined to virtual space. 3D rendering is how a model can be displayed.

**5. Computer animation:-**

Computer animation is an art of creating moving images via the use of computers. It is a sub-field of computer graphics and animation. Increasingly it is created by means of 3D computer graphics, though 2D computer graphics are still widely used for stylistic, low bandwidth, and faster real-time rendering needs. Sometimes target of the animation is the computer itself, but sometimes the target is another medium such as film. It is also referred to as CGI which is Computer-generated imagery or computer-generated imaging, especially when used in films.

Virtual entities can be controlled by assorted attributes, such as transform values I.e. location, orientation, and scale stored in an object's transformation matrix. Animation is change of an attribute over time. Multiple methods of achieving animation exist; rudimentary form is based on the creation and editing of key frames, each stores a value at a given time, per attribute to be animated. The 2D/3D graphics software will change with each key-frame, creating an editable curve of a value mapped over time, which results in animation. Other methods of animation include procedural and expression-based techniques: the former related elements of animated entities into sets of attributes, useful for creating particle effects and crowd simulations whereas the latter allows an evaluated result returned from a user-defined logical expression, coupled with mathematics, to automate animation in a predictable way.

To create any illusion of movement, an image must be displayed on the computer screen then quickly replaced by a new image that is similar to the previous image, but shifted slightly. This technique is similar to the illusion of movement in television and motion pictures.

**Color Models:-**

Color is a visual perceptual property corresponding in humans to the categories called red, blue, yellow, green and others. Color are derived from the spectrum of light or distribution of light power versus wavelength interacting in the eye with the spectral sensitivities of the light receptors

**RGB Color Model:-**

Media that transmit light such as television use additive color mixing with primary colors of red, green, and blue, each of which stimulates one of the three types of the eye's color receptors with as little stimulation as possible of the other two. This is called "RGB" color space. Mixtures of light of these primary colors cover a large part of the human color space due to which it produce a large part of human color experiences. This is why color television sets or color computer monitors need only produce mixtures of red, green and blue light.

Other primary colors could in principle be used, but with red, green and blue the largest portion of the human color space can be captured. Unfortunately there is no exact consensus as to what loci in the chromaticity diagram the red, green, and blue colors should have, so the same RGB values can give rise to slightly different colors on different screens.

**CMYK Color Model:-**

It is possible to achieve a wide range of colors seen by humans by combining cyan, magenta, and yellow transparent dyes or inks on a white substrate. These are the subtractive primary colors. Often a fourth ink, black, is added to improve reproduction of some dark colors. This is called "CMY" or "CMYK" color space.

The cyan ink absorbs red light but transmits green and blue, the magenta ink absorbs green light but transmits red and blue, and the yellow ink absorbs blue light but transmits red and green. The white substrate reflects the transmitted light back to the viewer. Because in practice the CMY inks suitable for printing also reflect a little bit of color, making a deep and neutral black impossible, the K (black ink) component, usually printed last, is needed to compensate for their deficiencies. Use of a separate black ink is also economically driven when a lot of black content is expected, e.g. in text media, to reduce simultaneous use of the three colored inks. The dyes used in traditional color photographic prints and slides are much more perfectly transparent, so a K component is normally not needed or used in those media.

## III. APPLICATIONS OF GRAPHICS

1. Paint programs : Allow you to create rough freehand drawings. The images are stored as bit maps and can easily be edited.

2. Illustration or design programs: Supports more advanced features than paint programs, particularly for drawing curved lines. The images are usually stored in vector-based formats. Illustration/design programs are often called draw programs.

3. Presentation graphics software's: 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.

4. Animation software: Enables you to chain and sequence a series of images to simulate movement. Each image is like a frame in a movie.

5. CAD software**:** Enables architects and engineers to draft designs.

6. 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.

In general, applications that support graphics require a powerful CPU and a large amount of memory. Many graphics applications for example, computer animation systems-require more computing power than is available on personal computers and will run only on powerful workstations or specially designed graphics computers. This is true of all three-dimensional computer graphics applications.

In addition to the CPU and memory, graphics software requires a graphics monitor and support for one of the many graphics standards. Most PC programs, for instance, require VGA graphics. If your computer does not have built-in support for a specific graphics system, you can insert a video adapter card.

The quality of most graphics devices is determined by their resolution-how many points per square inch they can represent-and their color capabilities

## IV. FUTURE SCOPE

Computer Vision is an area that studies how to make computers efficiently perceive, process, and understand visual data such as images and videos. The proposed goal is for computers to emulate the striking perceptual capability of human eyes and brains, or even to surpass and assist the human in certain ways. Visual Computing develops from mathematical theory to practical applications, from physical systems to software development, and from low-level image processing to high-level image understanding. Research results from some group have made fundamental impacts on many important applications such as New High-Resolution Cameras, Face Recognition, Image Search, Virtual Earth, and Graphics & Games.

## REFERENCES

[1] What is Computer Graphics?, Cornell University Program of Computer Graphics. Last updated 04/15/98. Accessed November 17, 2009.

[2] Jump up University of Leeds ISS (2002). "What are computer graphics?". Last updated: 22 September 2008

[3] Jump up Michael Friendly (2008). "Milestones in the history of thematic cartography, statistical graphics, and data visualization".

[4] Jump up John Francis Reintjes and Douglas T. Ross "Automatically Programmed Tools" (1959) Science Reporter TV Series

International Journal for Research in Applied Science & Engineering Technology(IJRASET)

[5] Jump up to: Wayne Carlson (2003) A Critical History of Computer Graphics and Animation. Ohio State University

[6] Jump up David Salomon (1999). Computer graphics and geometric modeling. p. ix

[7] Jump up Ira Greenberg (2007). Processing: Creative Coding and Computational Art. Après. ISBN 1-59059-617-X.

[8] Jump up Rudolf F. Graf (1999). Modern Dictionary of Electronics. Oxford: Newness. p. 569. ISBN 0-7506-4331-5.

[9] Jump up Blythe, David. Advanced Graphics Programming Techniques Using OpenGL. Sig graph 1999.