

# COMPUTER GRAPHICS MULTIMEDIA AND ANIMATION



THEORY AND PRACTICAL  
APPROACH

# Computer Graphics Multimedia And Animation [Unit-I]

## Syllabus

Subject Code	15BCA311	
Subject Name	Computer Graphics Multimedia & Animation	
Short Name	CGMA	
Total Teaching periods	88	
Total Credits	4	
Prerequisites :		
<ul style="list-style-type: none"><li>Basic knowledge about computer system, its components and functions.</li></ul>		
Objectives:		
<ul style="list-style-type: none"><li>To acquire the basic knowledge about Computer Graphics.</li><li>To learn the basic knowledge about various algorithms of Computer Graphics</li><li>To understand the various types of multimedia &amp; animation and compression techniques.</li></ul>		
Units	Contents	Total Lectures
I	<b>Introduction to Computer Graphics:</b> Introduction, history, characteristics, advantages & disadvantages, application, components. Adapters ,Coordinates representation, software standards, <b>Input devices:</b> keyboard, mouse, trackball, space ball, joysticks, image scanner, touch panel, light pen, and voice system, <b>File format:</b> GIF, JPEG, PNG, TIFF, MPEG	18
II	<b>Graphics Preemptive</b> <b>Display devices:</b> CRT, Raster Scan Display, Random Scan Display, Flat Panel Display, LCD. Virtual reality system, Raster Scan System, Random Scan System. <b>Output Primitives :</b> Points & line, DDA algorithm, Bresenham’s line algorithm, circle generation algorithm, <b>Attribute:</b> line, curve, text, area-fill	18
III	<b>Transformation and Clipping</b> <b>Transformation :</b> Introduction, translation, scaling, rotation, composite transformation, matrix representation, homogeneous coordinates, The Viewing Pipeline, Viewing Coordinate Reference Frame <b>Clipping:</b> point, Cohen-Sutherland Line Clipping, curve, text, exterior.	18
IV	<b>Multimedia and Compression</b> <b>Multimedia:</b> Introduction, overview, multimedia & hypermedia, advantages, disadvantages, application, software tools: music, Sequencing & notation, digital audio. <b>Compression:</b> introduction, need, types, evaluating & visibility, simple compression techniques, transform coding techniques.	17
V	<b>Animation:</b> Introduction, history, design of animation sequences, application, advantages, disadvantages, traditional animation, computer animation, tweening, morphing, case study on flash.	17
	<b>Text Books :</b> 1. Hearn d and Baker M. P, “Computer graphics-c version”, 2 <sup>nd</sup> edition Pearson Education. 2. Rajiv Chopda ,” Computer graphics ” revised edition S. Chand 3. ze-Nilan li, Mark S. Derw “Fundamental of multimedia”	
	1. Siamon J. Gibb And Dianysios c. Tsichritzis, “Multimedia Programming”,AddisonWesely, 1995. 2. Johan Villain, Casanova And LeonyFernanadez, Eliar, “Multimedia Graphics”, PHI, 1998 3. Malay K. Pakhira, Computer Graphics, Multimedia and Animation, 2 <sup>nd</sup> Edition, PHI Publication.	

**Q)List any four application of computer graphics and explain any one of it.**

**Q)List any eight application of computer graphics.**

**Q)Write down any 8 applications of computer graphics.**

## **1] Introduction of computer graphics**

The term computer graphics includes almost everything on computers that is not text. Today nearly all computers use some graphics and users expect to control their computer through icons and pictures rather than just b typing. The term Computer Graphics has several meaning like the representation and manipulation of pictorial data by a computer, the various technologies used to create and manipulate such pictorial data, the images so produced, and the sub-field of Computer science which studies methods for digitally synthesizing and manipulating visual content, see study of computer graphics.

Today computers and computer-generated images touch many aspect of our daily life. Computer imagery is found on television, in newspaper, in weather reports, and during surgical procedures. A well-constructed graph can present complex statistic in a form that is easier to understand and interpret. Such graphs are used to illustrate papers, reports, theses, and other presentation material. A range of tools and facilities are available to enable users to visualize their data, and computer graphics are used in many disciplines.

The computer is a data processing machine or we can say it is a tool which is used for storing , manipulating and displaying data. We can collect or generate data and process it according to users need. Let us say data is entered from keyboard in the form of 2 nos., say 10 and 20. Now we can process this data by performing some operation on it, say addition, so that we will get result as  $10+20=30$ . Here 30 is a result. It means here we have performed addition process on input data. This data is also called as information. This information can help us to make decisions and understand the world and control the operations. If the data elements are less in numbers then we can easily perform any operation. But as the volume of information increases a problem arises. Problems could be of type, more time required to process data, accuracy problem, understanding may be difficult etc. So, how can this large information be effectively and efficiently transferred between machine and human?

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## Computer Graphics Multimedia And Animation [Unit-I]

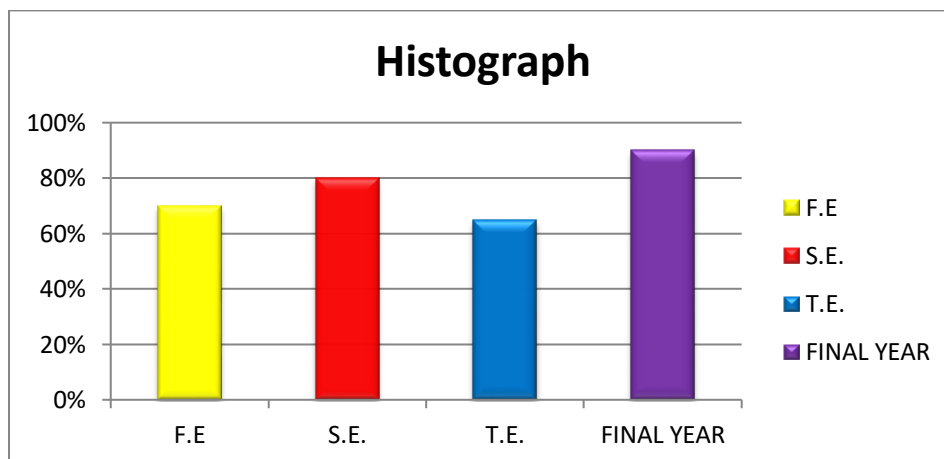
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A machine can easily generate hundred lines of code or thousand entries for a table. But such a code or table may be worthless if the human reader does not have time to go through it or understand it. If the reader is not going to read all the hundred lines of codes and analyze it then he will be doubtful about the output of that code. So even if the code may be correct as reader is not reading it sincerely, he is doubtful about the code. At this stage **Computer Graphics** is very useful.

Computer Graphics is the study of techniques to improve communication between Human and Machine. The word Computer Graphics means pictures, graph or scene is drawn with the help of computer. We can draw a graph which may replace that huge table of thousand entries and allow the reader to note the relevant patterns and characteristics at a glance. Here Computer represents the data provided to it in pictorial form. The input given by the user ,often alter the output presented by the machine.

A dialog can be established through the graphics medium. This is termed as **Interactive Computer Graphics**. Here interacts with Machine.

e.g. Histogram



Here we will provide input data to machine as result of F.E. to B.E. For F.E. result is 70% For S.E. is 80% For T.E. result is 65% For B.E. result is 90%.

If we draw histogram with this database it will be easy to understand and analyze the result of F.E. to B.E. i.e. which class is having minimum result etc. see the above fig. So, just by

# Computer Graphics Multimedia And Animation [Unit-I]

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working at one diagram we can answer many questions. By changing the input parameters we can modify the output picture i.e. if F.E. result increases from 70% to 80% then certainly the histogram is going to change.

Similarly the other examples could be pie-charts, cardiogram etc. cardiogram takes heart pulses as input and converts that input on graph paper.

Computer graphics allows communication through pictures, charts and diagrams, as there is old adage “Thousand words can be replaced by a single picture”.

## 1.1] Application of Computer Graphics

There are many applications of computer graphics and variety of fields in which it is applied such as,

- Engineering/Scientific Software, Business Software.
- T.V. channels, space simulation training.
- PCB designing, map preparation.
- User Interface, Animation.
- Making Charts, Image Processing.
- Office Automation
- Desktop Publishing
- CAD/CAM
- Arts & commerce
- Process Controlling
- ‘Visual Effects’ in Movies and Computer Games.

# Computer Graphics Multimedia And Animation [Unit-I]

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## 1.2] Graphics Areas:

It is very to categories any field like computer graphics, but most of graphics expert would agree on the following major areas:

- **Modeling** deals with geometrical/mathematical specification of an object and its visual properties in a way so they can be stored. For example that a glass of water might be specified with a set 3-D pixels along with some interpolation method to connect all the pixels.
- **Rendering** is the process of producing realistic images. It is a term inherited from art and deals with the creation of images.
- **Animation** is a method of creating an illusion of motion by flashing sequence of images at as specific rate. The speed should be more than 20images per second.

There are also many other areas involved in computer graphics, but whether they are included in core graphics areas is just a matter of opinion.

- **Image Processing** are techniques to modify or interpret existing pictures such as photographs.
- **Interactive graphics** provides a very utilitarian function by serving as one of the most natural means of communicating with the computer.

## Representative uses of Computer Graphics:

In today's world, usually in all the areas, computer graphics is helping in doing a number of things in an application area. For Example:

i. Computer Aided Design(CAD)	Design and drafting Mechanical parts Architecture Product design
ii. Art	Paintings Interactive works
iii. Education and Training	Process control (status display in-refineries, power plant, computer network) Architecture Medicine Flight Simulation Virtual Reality training
iv. Visualization	Geometrical representation Weather forecast (an accurate-schematic representation) Geography (Cartography, e.g.,geographic maps.) Medicines (X-rays)
v. Image Processing	MRI
vi. Graphical User Interface	Interactive technique Icons

# Computer Graphics Multimedia And Animation [Unit-I]

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	Windowing
vii. Entertainment	Virtual sets Animations Special effects in films Video Games Commercials
viii. Office Automation and Electronic Publishing	

## 1.3] Computer Graphics versus Image Processing:

Although methods used in computer graphics and image processing is moreover same, the two areas are concerned with fundamentally different operations. In **Computer Graphics**, a **computer is used to create a picture**. **Image Processing**, on the other hand, **applies techniques** to modify or interpret existing picture such as photographs.

Two principal application of image processing are:

- Improving the quality of the picture.
- Machine perception of visual information as used in robotics.

Computer graphics concerns the pictorial synthesis of real or imaginary object from their computer-based models; whereas the related field of image processing (also called picture processing) treats the converse process the analysis or the reconstruction of models of 2-D or 3-D objects from their pictures.

## 1.4] Classification of Computer Graphics:

There are different classifications in computer graphics given by various graphics practitioners. It is just a matter of opinion. Computer graphics can be categorized as follows:

- Screen-based graphics:** By writing directly to screen, by manipulating screen elements, e.g., paint program.
- Model-based graphics:** By writing to internal data structure and the data structure is 'rendered' onto screen, e.g., drawing programs.

Computer Graphics can also be classified as follows:

**Passive/Non-interactive graphics-** It involves the condition where the observer has no control over the image. Example: Titles shown on TV Logos and character generation etc.

**Interactive Graphics-** It provides a very utilitarian function by serving as one of the most natural means of communicating with a computer.

*Interactive computer graphics* involves 2 way communications between computer and user. The computer upon receiving signal from the input device can modify a display picture appropriately. To the user, it appears that the picture is changing instantaneously in response

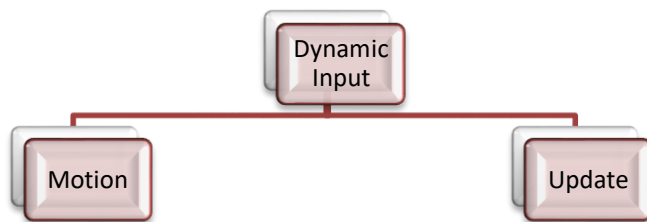
# Computer Graphics Multimedia And Animation [Unit-I]

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to his command. He can give service of commands, each one generating a graphical response from the computer. In this way, he maintains a conversation, or dialogue with the computer.

Interactive graphics is the most important means of producing pictures since the invention of photography and television, it has an added advantage that, we can make picture not only of concrete, “real world” object but also of abstract, synthetic objects (mathematical surfaces in 4-D), and of data that have no inherent geometry.

It is not confined to static image; even dynamically varying pictures can also be effectively shown.



Object can be moved and tumbled with respect to a stationary observer. The object can remain stationary and Viewer can move around them, e.g., Flight Simulator.

It is the actual change of the shape, Color, or other properties of the object being viewed.

Interactive computer graphics thus permits extensive, high-bandwidth user-computer interaction. This significantly enhances our ability to understand data, to perceive trends and to privatize real or imaginary objects.

## 1.3] Component of Computer Graphics:

Computer Graphics consist of three components:

- 1) Digital memory buffer (frame buffer).
- 2) Monitor
- 3) Video Controller

Picture Element

Update

Refresh





# Computer Graphics Multimedia And Animation [Unit-I]

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*Components required to see the output on screen in the form of pixel*

- 1) **Frame Buffer:** This is place where images or picture are store as an array in the form of 0's and 1's, 0 represents darkness and 1 represent image or picture.

Frame buffer is the video RAM (V-RAM) that is memory area that has the information about the image to be displayed on the screen. The amount of memory required to hold the image depend primarily on the resolution of the screen and also the color depth used per pixel. The formula to calculate how much video memory is required at a given resolution and bit depth is:-

$$\text{Memory in GB: } \frac{\text{X-resolution} * \text{Y-resolution} * \text{Bits per pixel}}{8 * 1024 * 1024 * 1024}$$

- 2) **Monitor:** The purpose of display device is to convert signal into visible images.
- 3) **Video Controller:** It is an interface between digital memory buffer and TV monitor. The main function of this is to pass the contents of frame buffer to the monitor.

## 1.4] Graphics Hardware:

Graphics Hardware consists of the following components:

- 1) Input Device
- 2) Display Device
- 3) Display Controller

### Input Device:

Various devices are available for data input on graphics workstation. These may be classified as:

- 1) Text Entry
- 2) Pointing Device

### Text Entry:

- **Button:** Buttons are very simple to use and easy to map with the functionality of any process. There are different types of buttons.
- **Keyboard:** This device is meant for discrete entries. This is a primary device for entering text strings. It is very efficient device for inputting non-graphic data. It has various layouts.

## 1.5] Pointing Device:

### Direct Pointing Device:

- **Light Pen:** Detects burst of light from screen phosphor. It addresses individual pixel. It contains a light sensitive cell, which detects the light from the screen enabling the computer to identity the location of the [pen on the screen.

## **Advantage:**

- Intuitive to use
- Good for Public access system like ATM's
- Good durability in high-use environment
- Enables users to choose from available options by simply touching the desired icon or menu item.

## **Disadvantage:**

- Inaccurate
- Greasiness on screen from figure, e.g., ATM machine, touch screen phone etc.
- Obscures part of the screen.
- Users come too close to screen for comfort.

## **Indirect Pointing Device:**

- **Mouse:** A mouse function as a pointing device used to position the screen cursor. You have to make selection with the help of button placed on the top of the mouse.  
Type of mouse based on mechanism:
  - 1) **Mechanical Mouse:** It is use a ball makes contact with inside wheels when it is rolled on a plain surface.
  - 2) **Optical Mouse:** As the name suggest, a mouse that use light to detect movements. It emits a ray of light and senses it reflection when it moves. Initial optical mouse required a special mouse pad, but a new device doesn't require the same.
- **Trackball:** A trackball is a pointing device that works like an upside-down mouse. It is used in portable computer.

## **Advantage:**

- It required no space.
- Ball can be rotated with the fingers or palm of the hand, to produce screen cursor movement.
- It is very popular with notebooks and portable computers.

## **2] Display Devices:**

- Cathode Ray Tubes (CRT's)
- Raster scan CRT
- Random Scan CRT or Vector Display
- Color CRT Monitors
- Direct View Storage Tube (DVST)

Computer graphics is generally regarded as a branch of computer science that deals with creation, storage and manipulation of models and images. In 1960, William Fetter coined the term "Computer Graphics" to describe his new design methods that he was pursuing at Boeing. Computer graphics is the study of techniques to enhance and include communication between human and machine. It allows communication through pictures, charts and diagrams to people.

# Computer Graphics Multimedia And Animation [Unit-I]

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By graphics, we will refer to any sketch, drawing or any other method that pictorially represent an object or data, or process to convey information, as a supplement to return description. The sketch may be a picture stating nature's beauty, cartoon, building or human behaviour. It may be just few regular lines on the screen.

Computer graphics is all these- "a consciously managed and documented technology directed towards communicating information accurately and descriptively." Anything that can be described in object space, as well as, in the image space is computer graphics such as:

- Digital representation and display of **spatial** and **non-spatial data**.
- Visual inspection of spatial and non-spatial data.
- Analysis and manipulation of spatial data.
- Digital representation of analog world.

It is very difficult to categorize any field like computer graphics, but most of the graphics expert would agree on the following major areas:

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- **Image processing** are techniques to modify or interpret existing picture such as photographs.
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## 2.1] Display/Video Adapters

**Que. Describe any two graphics mode functions with syntax.**

**Que. Define Resolution**

A video adapter or display adapter is an integrated circuit card in a computer that provides digital to analog converter, video RAM and a video controller so that data can be sent to computers display. Display adapter are characterized by,

- Resolution
- Color depth
- Refresh rate
- Acceleration

## Computer Graphics Multimedia And Animation [Unit-I]

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**Resolution** refers to the number of dots on the screen. It is expressed as a pair of numbers that give the number of dots on a horizontal line and the number of such vertical lines. Four resolutions are in common use today.

- 640\*480
- 800\*600
- 1024\*768
- 1280\*1024

Computer display generates colors by combining amounts of Red, Green and Blue. These colors are controlled by 3 wires in the display cable. Each has a variable amount of voltage represented by a number from 0 to 225. This produces up to 16 million possible colors.

**Color Depth (number of colors)** is determined by the number of bits assigned to hold color value.

- 1 bit - 2 colors (black and white)
- 4 bits - 16 colors
- 8 bits - 256 colors
- 16 bits - 32 thousand colors
- 24 bits - 16 million (high color)
- 32 bits - latest (true color)

The display adapter stores a value (4 to 32 bits) in memory for every dot on the screen. The amount of storage needed is determined by multiplying the number of dots (resolution) by the memory required for each dot.

e.g. for VGA having resolution 640\*480 with 4 bits color 256 KB memory is required. SVGA having resolution 800\*600 with 8 bits color, will need 512 KB memory.

### **Refresh rate:-**

Determine the speed that the display uses to paint the dots on the screen. The original VGA display runs at 60Hz, but some people complained that this produced flicker. Now it is 70Hz. A utility program is typically provided on diskette to set the refresh rate on the display adapter for various resolutions.

Acceleration chip on video card can draw lines and boxes. Fill in background color, scroll text and manage the mouse pointer. With an accelerator, the CPU only has to send the video adapter a command to draw a line(which may include starting point, ending point, width and color of line). The CPU is not required to calculate the points in the line. An accelerator and reduces the amount of data that must be transferred between PC and the display adapter.

### **2.2]Modes in computer graphics:**

Many video adapters support several different modes of resolution, all of which are divided into two general categories:

- Text mode /character mode
- Graphics mode.

#### **Text Mode:**

A video mode in which a display screen is divided into rows and columns of boxes. Each box can contain one character.

All video standards for the PC, including VGA, supports a text mode that divides the screen into 25 rows and 80 columns i.e. display screen is treated as an array of blocks, each of which can hold one ASCII character see the figure

### **2.3] Graphics Mode:**

In addition to text mode, most video adapters support a graphics mode, in which the display screen is divided into an array of pixels.

**Here we are introducing new term pixel.**

**(Definition of Pixel )** Pixel is the smallest addressable screen element. It is the smallest piece of the display screen which we can control. Each pixel has a name or address, so that we can uniquely identify that. Computer Graphics images are made by setting the intensity and color of the pixels.

Graphics mode is more sophisticated. Programs that run in graphics mode can display an unlimited variety of shapes and fonts, whereas programs running in text mode are severely limited. Programs that run entirely in graphics mode are called graphics based programs. Characters and other shapes are formed by turning on combinations of pixels.

## 2.4] Graphics Mode Function:

We will cover some of the standard library function here. As we have seen that, there are two different modes, namely text mode and graphics mode. In text mode it is possible to display or capture only text in terms of ASCII. But in graphics any type of figure can be displayed, captured and animated.

If we want to start graphics programming then you need two files which are GRAPHICS.H and GRAPHICS.LIB. These files are provided as part of turbo C and C++. The graphics mode functions require a graphics monitor and adapter card such as CGA, EGA and VGA. Now let us see some sample graphics programs.

## 3] Components of VDU

The video system consists of two basic components:

- a) A video screen on which we actually see the images either in text or in graphics.
- b) A video display adapter which is a special printed circuit board that plugs into one of the several expansion slots presents on the mother board of the computer. A video display adapter is sometimes simply referred as a video card.

How are the images, either text or graphics, produced on the screen? The microprocessor does not have the ability to send signals necessary to produce the images on the screen. This task is performed by the display. The display adapter acts as an agent between the microprocessor and the video screen. The display adapter consists of:

- a) Special memory called VDU memory.
- b) Circuitry which transfers the contents of the VDU memory on to the screen.

The microprocessor writes the information to be displayed on the screen into the VDU memory, whereas the display adapter circuitry transfers this information from VDU memory on to the screen. Therefore, we can describe the image displayed on the screen as a 'memory mapped display'. Each address in VDU memory corresponds to a specific location on the screen. The display adapter circuitry repeatedly (50 to 70 times a second) reads information from VDU memory and places it on the screen, making the images displayed on the screen clear and steady. This process is called 'refreshing the screen', and the rate at which the display adapter refreshes the screen is called 'refresh rate'. Low refresh rates cause the screen to flicker contributing to eye strain. The higher the refresh rate better it is for your eyes.

### 3.1] Display Adapters

A number of display adapters are available with varying capabilities. The 8086 family of microprocessors usually support the following display adapters:

- a) **Monochrome Adapter (MA)**
- b) **Hercules Adapter**
- c) **Color Graphics Adapter(CGA)**
- d) **Enhanced Graphics Adapter(EGA)**
- e) **Multicolor Graphics Adapter(MCGA)**
- f) **Video Graphics Array(VGA)**
- g) **Super Video Graphics Array(SVGA)**
- h) **Extended Graphics Adapter(XGA)**

Although clear differences exist between these different adapters, their strong family resemblance should encourage one to consider what they have in common before worrying about their differences.

Most of these adapters can be programmed in two fundamentally different modes, text mode and graphics mode. The lone exception is MA, which operates only in text mode. CGA and MA are usually called conventional display adapters and use B block of VDU memory, whereas MCGA, EGA, VGA, SVGA And XGA are called unconventional display adapters and use A block of VDU memory.

In text mode one can display only text characters (ACSII value 0 to 255), whereas, graphics mode is mainly used for complex drawings. However, in graphics mode, text characters can also be drawn in a variety of shapes and sizes.

The CGA, MCGA, EGA, VGA, SVGA and XGA can operate both in text and graphics mode to produce drawings and characters in several formats and colors. By contrast, MA can operate only in text mode and that too only in one color. EGA, VGA, SVGA and XGA offer better performance as regards the clarity and sharpness of the image and graphics and color capabilities as compared to MA, CGA or Hercules.

Let us now have a look at each of these adapters in brief.

#### **Monochrome Adapter (MA)**

The simplest and the first available adapter is the MA. This adapter can display only text(in single color) and has no graphics displaying capability. Originally this drawback only prevented the users from playing video games, but today, even the most serious business software uses graphics and color to great advantage. Hence, MA is no longer suitable, through it offers clarity and high resolution.

## **Color Graphics Adapter(CGA)**

For several years CGA was the most common display adapter, although its capabilities are quite limited from today's perspective. This adapter can display text as well as graphics. In text mode it operates in 25 row by 80 column mode with 16 colors. In graphics mode two resolutions are available from a palette of 16, and two-color high resolution mode(640 x 200).

One drawback of CGA card is that it produces flicker and snow. Flicker is the annoying tendency of the text to flash as it moves up or down. Snow is the flurry of bright dots that can appear anywhere on the screen.

## **Enhanced Graphics Adapter(EGA)**

The EGA was introduced by IBM in 1984 as an alternative to the CGA card. The EGA could emulate most of the functions and all the display modes of CGA as well as MA. The EGA offered higher resolution and was not plagued with the snow and flicker problems of the CGA. In addition to the monochrome and color displays designed for the MA and the CGA, the EGA could use the enhanced color monitor capable of displaying 640 x 350 pixels in 16 colors from a palette of 64.

The EGA card has several internal registers. A serious limitation of the EGA card is that it supports write operations to most of its internal registers, but no read operations. As a result, it is not possible for the software to detect and preserve the state of the adapter, which makes EGA unsuited for memory resident applications or for multitasking environments like Windows and OS/2.

## **Multicolor Graphics Adapter(MCGA)**

The MCGA was designed to emulate the CGA card and to maintain compatibility with all the CGA modes. In addition to the text and graphics modes of the CGA, MCGA has two new graphics modes: a 640 x 480 pixel mode in 2 colors and 320 x 200 pixelmode in 256 colors. The MCGA system was short-lived since soon after its launch IBM started supplying the VGA card.

## **Video Graphics Array(VGA)**

The VGA card supports all the display modes of MA, CGA, MCGA and EGA. In addition VGA supports a graphics mode of 640 x 480 pixels resolution in 16 colors.



### 4] Q. Describe Cartesian co-ordinate system.

**Ans:**

- In Cartesian co-ordinate system, any point in 2D is addressed by its x and y coordinates, where x coordinate is distance of a point from origin measured along x direction and y coordinates are distance of a point from origin measured along y direction and where x and y perpendicular to each other.
- In 3D, any point is addressed by its x,y and z coordinates. any point P may be represented by the three signed numbered frequently written (x,y,z) where the coordinate is the perpendicular distance from the plane formed by the other two axes.
- Often positions are specified by a position vector r which can be expressed in terms of the coordinate values and associated unit vectors.
- Even though the entire coordinate system can be rotated, the relationship between the axes is fixed, in what is called a right handed coordinate system.
- The distance between any two points in rectangular coordinates (or Cartesian coordinates) can be found from the distance relation.

### 4.1] Q. Describe polar coordinate system.

The polar coordinate system is a two dimensional co-ordinate system in which each point on a plane is determine by an angle and a distance.

- 2D Cartesian (x, y) coordinate corresponds to polar (r,  $\theta$ ) coordinates i.e. point P is addressed by distance r of radius vector from origin and angle  $\theta$  which it makes in counter clockwise rotation from reference x axis.
- Each point in the polar coordinate system can be described with the two polar coordinates, which are usually called the r (the radial coordinates) and  $\theta$  (the angular co-ordinate).
- The r coordinate represents the radial distance from the pole, and the  $\theta$  coordinate represents the anticlockwise angle from the  $0^\circ$  ray, known as the positive X-axis on the Cartesian coordinate plane.
- For example, the polar coordinate (4,  $60^\circ$ ) would be plotted as a point 4 units from the pole on the  $60^\circ$  ray.
- The two polar coordinates r and  $\theta$  can be converted to the Cartesian coordinates x and y by using the trigonometric functions sine and cosine.

$$X = r \times \cos \theta$$

$$Y = r \sin \theta$$

### 5] Q. What are Additive and Subtractive color system?

Ans: Additive Color System:

- Colors in additive systems are created by adding colors to black to create new colors.
- The more color that is added, the more the resulting color tends towards white.
- The presence of all the primary colors in sufficient amount creates pure white, while the absence of all the primary colors creates pure black.
- Additive color environments are self-luminous.
- Color on monitors is an example of additive color system.

Subtractive Color System:

- In subtractive color system, primary colors are subtracted from white to create new colors.
- The more color that is subtracted, the more the resulting color tends towards black.
- The presence of all primary colors creates pure black, while the absence of all primary colors creates pure white.
- Subtractive environments are reflective in nature, and color is conveyed by reflecting light from an external source.
- Any color image reproduced on paper is an example of a subtractive color system.

### 5.1] Q. Explain RGB (Red-Green-Blue) color system.

Ans:

- RGB is the most widely used color system in image formats.
- It is an additive system in which varying amounts of the colors red, green, and blue are added to black to produce new colors.
- Graphics files using the RGB color system represent each pixel as a color triplet-three numerical value in the form (R, G, B) each representing the amount of red, green and blue in the pixel, respectively.
- When the three RGB values are set to the same value- for example(63,63,63) – the resulting color is a shade of grey.

### 5.2] Q. Describe CMY (Cyan-Magenta-Yellow) color system.

Ans:

- CMY is a subtractive color system used by printer and photographers for the rendering of colors with ink or emulsion normally on a white surface.
- CMY is used by most hard copy devices that deposit color pigments on white paper, such as laser and ink-jet printers.
- When illuminated each of the three colors absorbs its complementary light color.
- Cyan absorbs red, magenta absorbs green and yellow absorbs blue. By increasing the amount of yellow ink, the amount of blue in the image is decreased.

## Computer Graphics Multimedia And Animation [Unit-I]

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- CMY system has spawned a practical variant, CMYK, with K standing for the color black.
- In many real-world color composition systems, the four CMYK color components are specified as percentages in the range of 0 to 100.

### 5.3] Q. Write short note on HSV (Hue, Saturation and Value) color system.

Ans:

- HSV is one of many color systems that vary the degree of properties of colors to create new colors, rather than using a mixture of the colors themselves.
- Hue specifies "color" in the common use, such as red, or blue and so on.
- Saturation (also called chroma) refers to the amount of white in a hue; a fully (100 per cent) saturated hue contains no white and appears pure.
- Value (also called brightness) is the degree of luminescence of a color that is, how much light it emits.
- A hue with high intensity is very bright while a hue with low intensity is dark.

### 6 ] Q. Graphics file format

#### What do you mean by graphics file format?

File format used to store information of image is called graphics file format

These file formats store information of pixels of image as incorporate some method of data compression.

**Commonly used graphics file formats are BMP, GIF, JPEG, PCX and TIFF.**

#### 1) Explain BMP(Bitmap) file format

- BMP is the default format used by MS-Windows
- In BMP Storing and manipulation of pixel is done with their location and attribute by bit coding method

Name	Windows Bitmap
Dos file extension	BMP
Format type	Bitmap
Color Capabilities	2,16,256 or 16 million colors

#### What are advantages and disadvantages of Bitmap file format

##### advantages

- Format is simple to use
- BMP is display device independent

## Disadvantages

- The size of file is very large
- The cannot store multiple images in one file

## 2) GIF (Graphics Interchange format)

- GIF is simple, memory efficient and back bitmap format. It can be used with most bitmap editing programs.
- It compresses BMP files to much smaller size.
- GIF stores images and other relevant information in sequence of blocks and sub-blocks where each sub-block has different function regarding image information, colour, brightness and data compression.
- Graphics Interchange Format allows high-quality, high resolution graphics to be displayed on a variety of graphics hardware and is intended as an exchange and display mechanism for graphics images.

Name	Windows Bitmap
Dos file extension	BMP
Format type	Bitmap
Color Capabilities	Index color palette up to 256 color
Compression	LZW

## Advantage of GIF

- It is device independent.
- It is operating system independent.
- It gives compact file format.
- It allows multiple image to be stored in a single file.
- It is suitable in Internet and Intranet.

## Disadvantages of GIF

- Decompression of GIF data is slow.
- It uses only palette colour.
- It do not provide other RBG colour and gray scale.

### 3) JPEG (Joint photographic expert group)

JPEG is special bitmap image format used to reduce file drastically. It is used with photographic images.

JPEG is a lossy compression technique for color images.

JPEG are better suited to displaying natural complex images.

The JPEG standard specifies both code, which defines how an image is compressed back into an image, and the file format used to contain that stream.

Name	Windows Bitmap
Dos file extension	JPG
Format type	Bitmap image compression
Color Capabilities	2,16.256or 16milloion. colors 32 bit color depth

#### Advantages of JPEG

- JPEG is the format used for storing and transmitting photographs on the world wide web.
- JPEG produces much larger image files due to its lossless compression.
- It reduces file size.

#### Disadvantages of JPEG

- The JPEG compression algorithm is not well suited for line drawing and other textual or iconic graphics.
- In this format, some information or image is lost.

### TIFF (Tagged Image File Format)

TIFF, a tag based file format is designed to promote the interchange of digital image data. It stores image data. It stores image data in tagged fields.

A TIFF file is a sequence of 8-bit bytes where bytes are numbered from 0 to N.

The largest possible TIFF file is 232 bytes in length.

A TIFF file consists of three fields: image file header, image file directory and tag field where each one I identified by a unique tag.

#### Advantage of TIFF

- It is independent on any computer architecture and operating system
- It is versatile and flexible.
- It supports many compression schemes.
- File is quite compact.

## Computer Graphics Multimedia And Animation [Unit-I]

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- It stores additional information about images in the file which can be used to display image precisely and correctly.

Name	Windows Bitmap
Dos file extension	TIF
Format type	Bitmap
Color Capabilities	Monochrome (1bit) gray scale (4,8,16) palette color (up to 48 bit) CMYK COLOR
Compression	LZW

### Disadvantages of TIFF

- It is a complex file format as compared to BMP file format.
- As it is open ended, format changes made by programmer may not be compatible with its newer version.
- It does not support multiple images in one file.

### PCX(Personal computer exchange)

- PCX is a widely used format for storing images.
- It is a graphics file format for graphics programs running on PCs.
- The PCX is a device independent raster image format. The file header stores information about the display header separately from the actual image information, allowing the image to be properly transferred and displayed on computer system with different hardware.
- PCX image data is compressed using run-length encoding. The RLE compression algorithm requires very little processor power or memory to apply.

Name	Z- SOFT PC paint brush
Dos file extension	PCX
Format type	Bitmap
Color Capabilities	1-,2-,4-,8-,24-bit color, no Gray scale
Compression	RLE compression

### Advantages of PCX

- It is most widely used bitmap image format.
- PCX image data is compressed using run-length encoding (RLE).

### Disadvantages of PCX

- It is no provision for gray scale images.
- No provision for any other colour other than RGB.
- It does not support other platform

# Computer Graphics Multimedia And Animation [Unit-I]

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Graphics programming is used to drawing various geometrical shapes(rectangle, circle, ellipse etc), use of mathematical function in drawing curves, coloring an object with different colors and patterns and simple animation programs like jumping ball and moving cars.

## 1. First graphics program (Draw a line)

```
#include<graphics.h>
#include<stdio.h>
#include<conio.h>

void main(void){
    int gdriver= DETECT, gmode;
    initgraph(&gd,&gm,"C:\\TC\\BGI")
    clrscr();

    initgraph(&gdriver,&gmode,"c:\\turbo3\\bgi");
    line(x1, y1, x2, y2);
    getch();
    closegraph();
}
```

## 2. Explanation of Code :

The first step in any graphics program is to include **graphics.h** header file.

The **graphics.h** header file provides access to a simple graphics library that makes it possible to draw lines, rectangles, ovals, arcs, polygons, images, and strings on a graphical window.

The second step is initialize the graphics drivers on the computer using **initgraph** method of **graphics.h** library.

```
void initgraph(int*graphicsDriver,int*graphicsMode,char*driverDirectoryPath);
```

It initializes the graphics system by loading the passed graphics driver then changing the system into graphics mode. It also resets or initializes all graphics settings like color, palette, current position etc, to their default values. Below is the description of input parameters of **initgraph** function.

- **graphicsDriver** : It is a pointer to an integer specifying the graphics driver to be used. It tells the compiler that what graphics driver to use or to automatically detect the drive. In all our programs we will use **DETECT** macro of **graphics.h** library that instruct compiler for auto detection of graphics driver.

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## Computer Graphics Multimedia And Animation [Unit-I]

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- **graphicsMode** : It is a pointer to an integer that specifies the graphics mode to be used. If **\*gdriver** is set to **DETECT**, then **initgraph** sets **\*gmode** to the highest resolution available for the detected driver.
- **driverDirectoryPath** : It specifies the directory path where graphics driver files (**BGI files**) are located. If directory path is not provided, then it will search for driver files in current working directory. In all our sample graphics programs, you have to change path of BGI directory accordingly where you Turbo C++ compiler is installed.

We have declared variables so that we can keep track of starting and ending point.

```
int x1=200, y1=200;  
int x2=300, y2=300;
```

No, We need to pass just 4 parameters to the **line** function.

```
line(x1,y1,x2,y2);
```

**line** Function Draws Line From (x1,y1) to (x2,y2) .

Syntax : `line(x1,y1,x2,y2);`

### Parameter Explanation

- x1 - X Co-ordinate of First Point
- y1 - Y Co-ordinate of First Point
- x2 - X Co-ordinate of Second Point
- y2 - Y Co-ordinate of Second Point

At the end of our graphics program, we have to unload the graphics drivers and sets the screen back to text mode by calling **closegraph** function.

### 3. Colors in C Graphics Programming

There are 16 colors declared in `graphics.h` header file. We use colors to set the current drawing color, change the color of background, change the color of text, to color a closed shape etc (Foreground and Background Color). To specify a color, we can either use color constants like `setcolor(RED)`, or their corresponding integer codes like `setcolor(4)`. Below is the color code in increasing order.



CONSTANT	VALUE	BACKGROUND?	FOREGROUND?
BLACK	0	Yes	Yes
BLUE	1	Yes	Yes
GREEN	2	Yes	Yes
CYAN	3	Yes	Yes
RED	4	Yes	Yes
MAGENTA	5	Yes	Yes
BROWN	6	Yes	Yes
LIGHTGRAY	7	Yes	Yes
DARKGRAY	8	NO	Yes
LIGHTBLUE	9	NO	Yes
LIGHTGREEN	10	NO	Yes
LIGHTCYAN	11	NO	Yes
LIGHTRED	12	NO	Yes

LIGHTMAGENTA	13	NO	Yes
YELLOW	14	NO	Yes
WHITE	15	NO	Yes
BLINK	128	NO	*

\*\*\*\*\* To display blinking characters in text mode, add BLINK to the foreground color.  
(Defined in `conio.h`)

#### 4. Graphics example using color

```
//Include the graphics header file
#include<graphics.h>
#include<stdio.h>
#include<conio.h>

void main()
{
//Initialize the variables for the graphics driver and mode
int gd= DETECT, gm;
clrscr();
initgraph(&gd,&gm,"C:\\TURBOC3\\BGI");

//Set the color of the object you want to draw.
setcolor(BLUE);

//Draw an object. For this example,drawing a rectangle using the rectangle function
rectangle(50,50,100,100);

getch();
```

```
//unloads the graphics drivers  
closegraph();  
}
```

### 7] Computer - Input Devices

Following are some of the important input devices which are used in a computer –

- Keyboard
- Mouse
- Joy Stick
- Light pen
- Track Ball
- Scanner
- Graphic Tablet
- Magnetic Ink Card Reader(MICR)

#### Keyboard

Keyboard is the most common and very popular input device which helps to input data to the computer. The layout of the keyboard is like that of traditional typewriter, although there are some additional keys provided for performing additional functions.



Keyboards are of two sizes 84 keys or 101/102 keys, but now keyboards with 104 keys or 108 keys are also available for Windows and Internet.

The keys on the keyboard are as follows –

S.No	Keys & Description
1	<b>Typing Keys</b>  These keys include the letter keys (A-Z) and digit keys (09) which generally give

	the same layout as that of typewriters.
2	<b>Numeric Keypad</b> It is used to enter the numeric data or cursor movement. Generally, it consists of a set of 17 keys that are laid out in the same configuration used by most adding machines and calculators.
3	<b>Function Keys</b> The twelve function keys are present on the keyboard which are arranged in a row at the top of the keyboard. Each function key has a unique meaning and is used for some specific purpose.
4	<b>Control keys</b> These keys provide cursor and screen control. It includes four directional arrow keys. Control keys also include Home, End, Insert, Delete, Page Up, Page Down, Control(Ctrl), Alternate(Alt), Escape(Esc).
5	<b>Special Purpose Keys</b> Keyboard also contains some special purpose keys such as Enter, Shift, Caps Lock, Num Lock, Space bar, Tab, and Print Screen.

### Mouse

Mouse is the most popular pointing device. It is a very famous cursor-control device having a small palm size box with a round ball at its base, which senses the movement of the mouse and sends corresponding signals to the CPU when the mouse buttons are pressed.

Generally, it has two buttons called the left and the right button and a wheel is present between the buttons. A mouse can be used to control the position of the cursor on the screen, but it cannot be used to enter text into the computer.



## Advantages

- Easy to use
- Not very expensive
- Moves the cursor faster than the arrow keys of the keyboard.

## Joystick

Joystick is also a pointing device, which is used to move the cursor position on a monitor screen. It is a stick having a spherical ball at its both lower and upper ends. The lower spherical ball moves in a socket. The joystick can be moved in all four directions.



The function of the joystick is similar to that of a mouse. It is mainly used in Computer Aided Designing (CAD) and playing computer games.

## Light Pen

Light pen is a pointing device similar to a pen. It is used to select a displayed menu item or draw pictures on the monitor screen. It consists of a photocell and an optical system placed in a small tube.



When the tip of a light pen is moved over the monitor screen and the pen button is pressed, its photocell sensing element detects the screen location and sends the corresponding signal to the CPU.

## Track Ball

Track ball is an input device that is mostly used in notebook or laptop computer, instead of a mouse. This is a ball which is half inserted and by moving fingers on the ball, the pointer can be moved.



Since the whole device is not moved, a track ball requires less space than a mouse. A track ball comes in various shapes like a ball, a button, or a square.

### Scanner

Scanner is an input device, which works more like a photocopy machine. It is used when some information is available on paper and it is to be transferred to the hard disk of the computer for further manipulation.



Scanner captures images from the source which are then converted into a digital form that can be stored on the disk. These images can be edited before they are printed.

### Digitizer

Digitizer is an input device which converts analog information into digital form. Digitizer can convert a signal from the television or camera into a series of numbers that could be stored in a computer. They can be used by the computer to create a picture of whatever the camera had been pointed at.



Digitizer is also known as Tablet or Graphics Tablet as it converts graphics and pictorial data into binary inputs. A graphic tablet as digitizer is used for fine works of drawing and image manipulation applications.

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### Magnetic Ink Card Reader (MICR)

MICR input device is generally used in banks as there are large number of cheques to be processed every day. The bank's code number and cheque number are printed on the cheques with a special type of ink that contains particles of magnetic material that are machine readable.



This reading process is called Magnetic Ink Character Recognition (MICR). The main advantages of MICR is that it is fast and less error prone.

OCR scans the text optically, character by character, converts them into a machine readable code, and stores the text on the system memory.

### Bar Code Readers

Bar Code Reader is a device used for reading bar coded data (data in the form of light and dark lines). Bar coded data is generally used in labeling goods, numbering the books, etc. It may be a handheld scanner or may be embedded in a stationary scanner.



Bar Code Reader scans a bar code image, converts it into an alphanumeric value, which is then fed to the computer that the bar code reader is connected to.