Compute Graphics

Computer Graphics is generally regarded as a **branch** of **computer science** that **deals** with the **theory** and **technology** for **computerized image synthesis.**

কম্পিউটার গ্রাফিক্সকে সাধারণত কম্পিউটার বিজ্ঞানের একটি শাখা হিসাবে বিবেচনা করা হয় যেটি কম্পিউটারাইজড ইমেজের জন্য তত্ত্ব এবং প্রযুক্তি নিয়ে কাজ করে
সংশ্লেষণ

Computer graphics *refers* to the **field** of **visual computing** that **focuses** on **the creation**, **manipulation**, and **rendering** of ***images* using computers.** It encompasses a wide range of techniques and technologies used to **generate** and **manipulate visual content** for various purposes, including **art, design, entertainment, simulation, scientific visualization, and more.**

Computer graphics can be **broadly categorized** into **two main areas**:

2D Graphics: **Two-dimensional *graphics*** *involve* the **creation** and **manipulation** of **images** in a **plane**. This includes techniques such as **raster graphics (pixel-based images**), **vector graphics** (based on mathematical equations), and **image editing** software like **Adobe Photoshop, GIMP, etc.**

3D Graphics: **Three-dimensional graphics** involve the **creation** and **manipulation** of **objects** in a **three-dimensional space**. This includes techniques such as **3D modeling** (creating objects in three dimensions), rendering (**generating 2D images** from **3D models**), **animation**, and **computer-aided design** (CAD). **3D graphics** are **widely used** in industries such as animation, gaming, architecture, virtual reality, and film production.

Computer graphics **techniques** and **algorithms** include **rendering algorithms** (such as **ray tracing**, **rasterization**, and **global illumination**), **shading models** (such as **Phong shading**, **Lambertian shading**), **texture mapping**, **geometric transformations**, and **animation techniques** (such as **keyframing**, **skeletal animation**).

Overall, **computer graphics play** a **crucial role** in **creating realistic** and **immersive visual experiences** in **various applications** and **industries**.

Object Space is a 3 dimensional space in which a **graphic object is defined**
Image Space is a **Projection** of the **object defined** in to **two dimensional screen space**

Image Processing
Image processing is a **method** to **perform some operations on an image**, in order to get an **enhanced image** or to **extract some useful information from it.**

1.1 Exercise**: Difference between Computer Graphics and Image Processing**

Here's a table summarizing the key differences between computer graphics and image processing:

Aspect	Computer Graphics	Image Processing
Focus and Purpose	**Creation**, **manipulation**, and **rendering** of **visual content**, **including 2D** and **3D graphics, animations**, and **virtual environments.**	**Analyzing**, **enhancing**, and **manipulating existing digital images, extracting information, improving quality**, and performing tasks like **pattern recognition** and **image restoration.**
Input Data	Often involves **creating graphical content** from **scratch** or using predefined **models, textures, and parameters.**	**Operates on pre-existing images** captured from various sources such as **cameras**, **scanners**, or **generated** by **other means**.
Algorithms and Techniques	Utilizes algorithms for **modeling objects**, **defining their properties** (e.g., **shape**, **color**, **texture**), **rendering techniques**, and **simulating lighting** and **shadows**.	Involves algorithms for tasks like **filtering**, **segmentation,edge detection**, **image enhancement** , **feature extractio**n, and **recognition**.
Applications	Widely used in **entertainment** (e.g., **video games, movies, animation**), design (e.g., **CAD**), **user interfaces** (UIs).	Applied in medical imaging (e.g., **MRI, CT scans**), **satellite imaging**, **biometrics**, **surveillance**, **document processing**, and **scientific analysis.**

Output	Outputs **graphical representations** that may or may not resemble **reality**, often **designed** for **aesthetic** or **informative** **purposes.**	Outputs **processed images** that may be **used for analysis, interpretation**, or to **improve** their **visual quality** or **suitability** for specific applications.

This table provides a clear overview of the distinctions between computer graphics and image processing, highlighting their respective focuses, techniques, applications, and outputs.

Object Space
- **3 dimensional space** in which a **graphic object** is **defined**
Image Space
- **Projection** অভিক্ষেপ of the **object defined** in to **two dimensional screen space**

Difference

Aspect	Object Space	Image Space
Definition	**Coordinate system** of **graphical objects/models**	**Coordinate system** of the **final rendered image**
Coordinates	**Relative** to **object's local origi**n and **orientation**	**Expressed** in **terms** of **pixels** on the **display**
Purpose	**Define position**, **orientation**, and **scale** of **objects**	**Represent visual content of the scene on screen**
Transformations	**Translation, rotation, scaling applied to objects**	**Rasterization, pixel manipulation, compositing**
Origin	**Object's local origin**	Top-left corner of the image or screen

This table outlines the key differences between object space and image space in terms of their definition, purpose, coordinates, transformations, and origin. Understanding

these differences is crucial for working effectively in computer graphics and rendering pipelines.

Chapter 2
Image Representation

Pixels is a **Picture of Elements**
- **Discrete units** forming the **image**
- **Arranged** in a **row-and-column fashion**
Resolution: Pixels of per **unit length** (e.g., inch) in **horizontal** and **vertical directions**.
Aspect Ratio: **Ratio** of **width** to **height i.e 1920/1080 = 96/54 = 48/27 = 16/9**

1) To compute the size of a 640 x 480 image at **240 pixels per inch**, we can use the formula:
Size = **(Width / Pixels per inch)** x **(Height / Pixels per inch)**
Substituting the values:
Size = (640 / 240) x (480 / 240)
= 2.66666667 x 2
= 5.33333333 square inches

2) To compute the resolution of a 2 x 2 inch image that has 512 x 512 pixels, we can use the formula:
Resolution = **(Width in pixels / Width in inches)** x **(Height in pixels / Height in inches**)
Substituting the values:
Resolution = (512 / 2) x (512 / 2)
= 256 x 256
= 65536 pixels per square inch

If an image has a height of 2 inches and an aspect ratio of 1.5, we can calculate its width using the formula for aspect ratio:
3) **Aspect Ratio = Width / Height**
Substituting the values, we have:
1.5 = Width / 2
Solving for width:
Width = 1.5 * 2
= 3 inches

4) To resize a **1024** x **768** image to one that is **640** pixels **wide** with the **same aspect ratio**, we need to maintain the aspect ratio when resizing. We can calculate the **height** of the resized image using the formula:

New Height = (**Original Height / Original Width**) x **New Width**

Substituting the values:
New Height = (768 / 1024) x 640
= 0.75 x 640
= 480 pixels

RGB Color Model

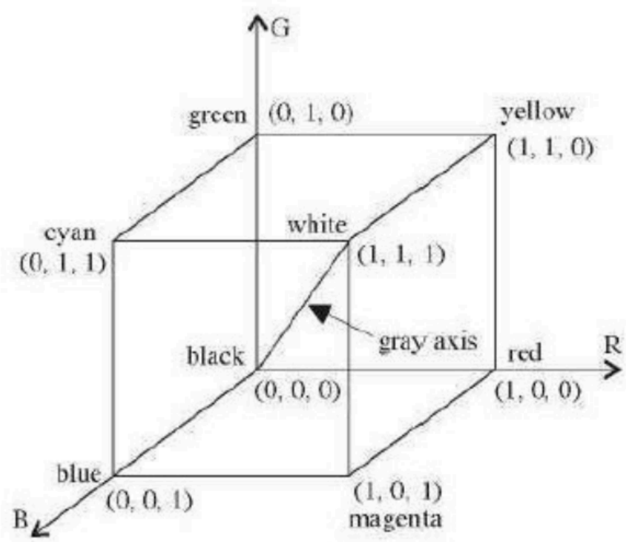

Fig. 2-1 The RGB color space.

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CMY Color Model

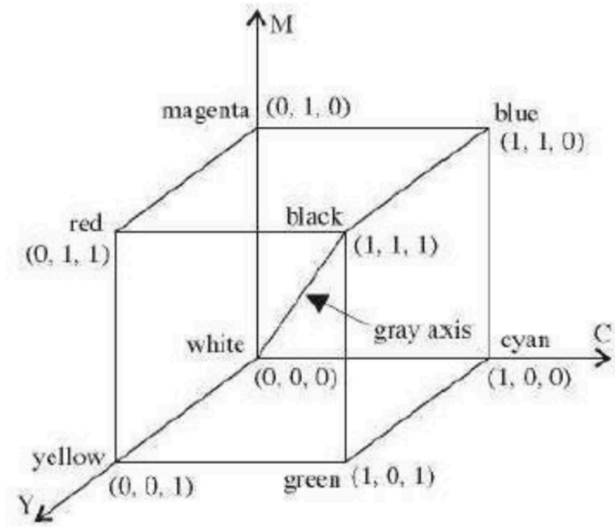

Fig. 2-2 The CMY color space.

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RGB ↔ CMY

$$\begin{pmatrix} R \\ G \\ B \end{pmatrix} = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix} - \begin{pmatrix} C \\ M \\ Y \end{pmatrix} \qquad \begin{pmatrix} C \\ M \\ Y \end{pmatrix} = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix} - \begin{pmatrix} R \\ G \\ B \end{pmatrix}$$

Exercise

1. Find the CMY coordinates of a color at (0.2,1,0.5) in the RGB space.

To find the CMY (Cyan, Magenta, Yellow) coordinates of a color in the RGB space, you can use the following formulas:

C = 1 - R
M = 1 - G
Y = 1 - B

Given the RGB coordinates (0.2, 1, 0.5), we can calculate the CMY coordinates as follows:

C = 1 - **0.2** = **0.8**
M = 1 - **1** = **0**
Y = 1 - **0.5** = **0.5**

Therefore, the CMY coordinates of the color with RGB coordinates (0.2, 1, 0.5) are (**0.8, 0, 0.5**).