

Introduction to Computer Graphics

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Frederick Li

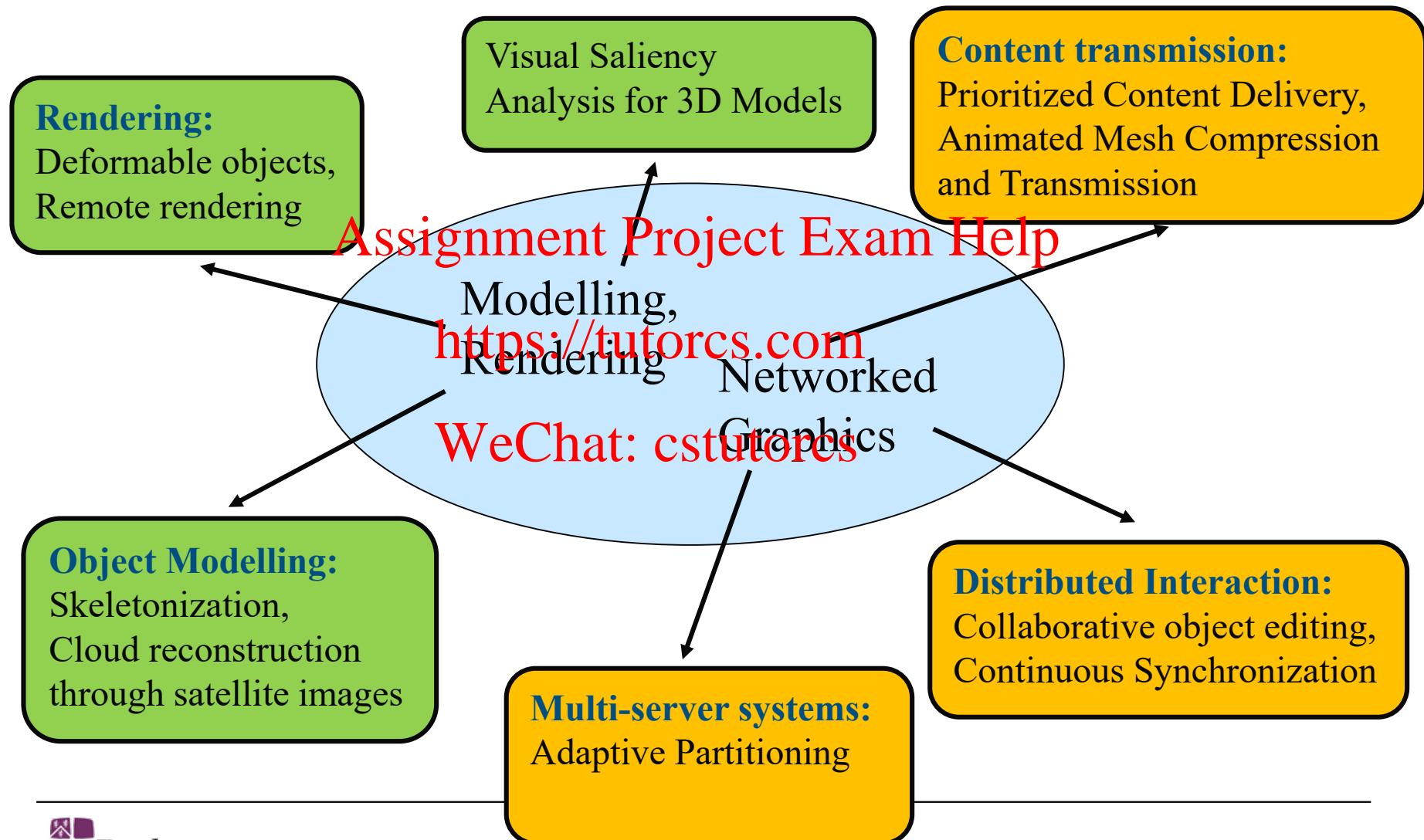
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My Research in Computer Graphics



This Lesson

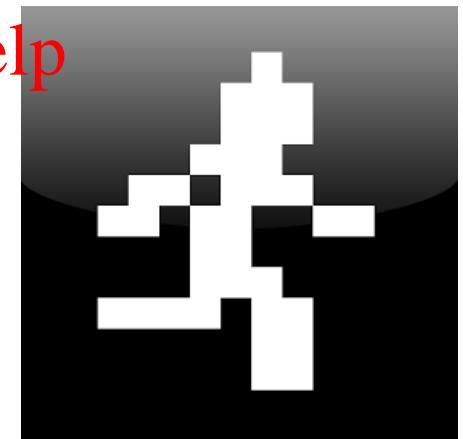
- Introduction to computer graphics
- Overview of major techniques involved in graphics applications **Assignment Project Exam Help**
- <https://tutorcs.com>**
- Understand architectures and operations of modern graphics hardware **WeChat: cstutorcs**
- Knowledge on popular graphics software tools and programming libraries

Simple Graphics Application in the Old Days



Lode Runner (Brøderbund, 1983).

2D Image Based
Modeling



Display at a suitable
screen position

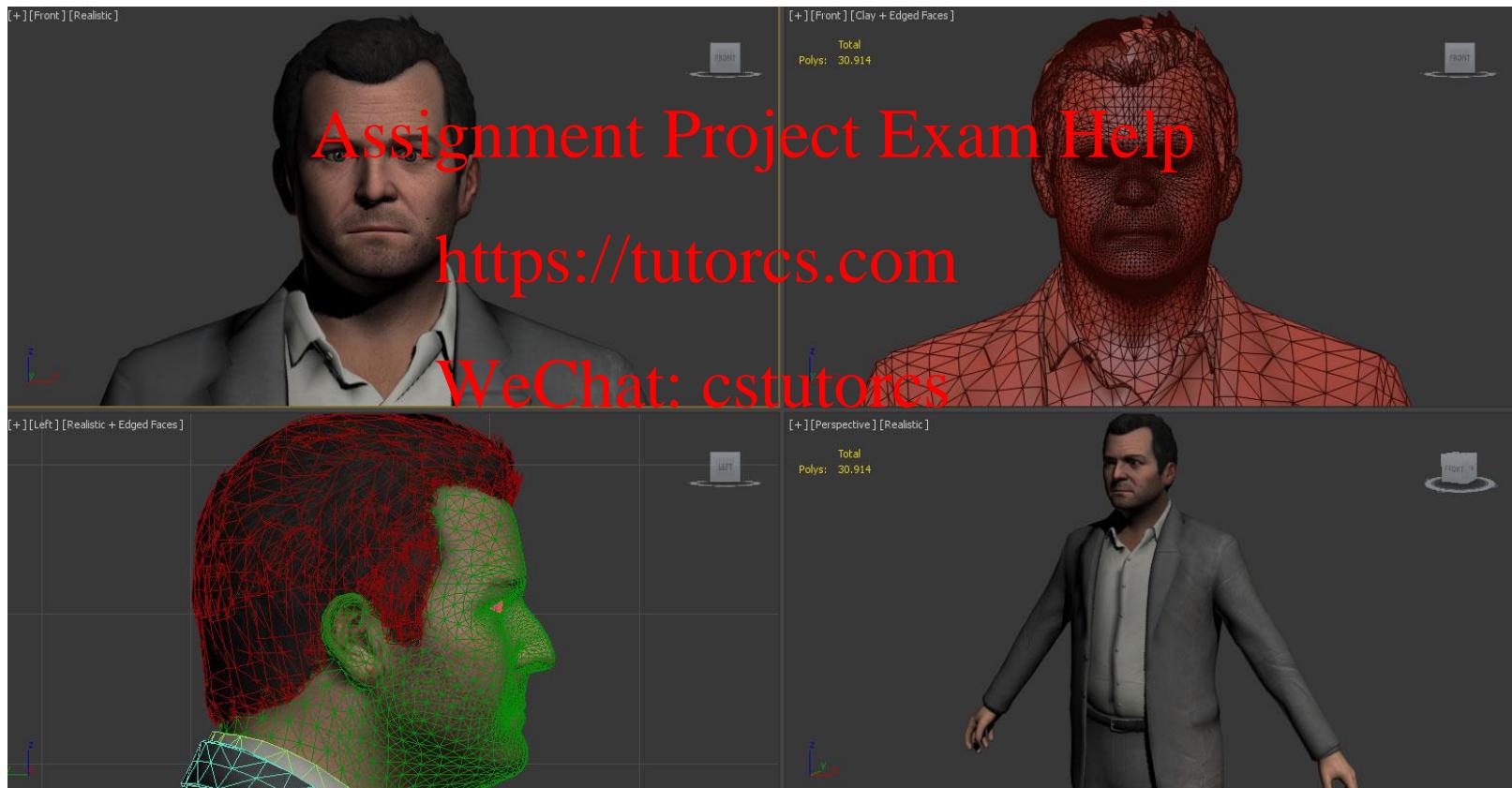
Modern 3D Graphics



Assassin's Creed Origins, Ubisoft 2017

3D Object Modeling

- Model human object by polygon model (3D object composed of polygons), followed by transformation, colouring, animation



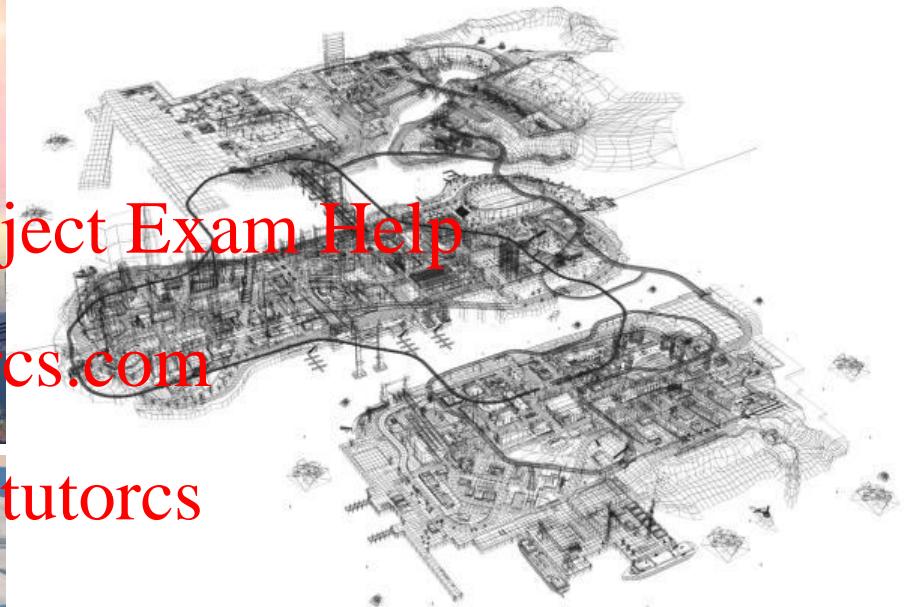
3D Scene Modeling



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Modeling of Landscape, Individual Buildings / Objects

Figures: Simple Shading, Wireframe, and final rendered image

Rendering – A multi-part process

- Rendered result



Diffusive Lighting



Levels of Detail

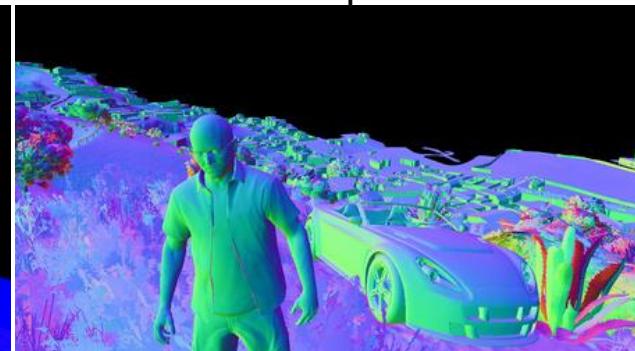
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Specular Lighting

Normal Map



Realistic Rendering Effects



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Fog Effect
(Depth of View)

Sunlight
Reflection

Water
Flow

Realistic Rendering Effects (2)



Mirror
Image

Simulate
Natural Phenomena

Environment
Reflection

Movie and Computer Graphics (CG)

Green Screen

- facilitates the composition of real-life objects and CG effects

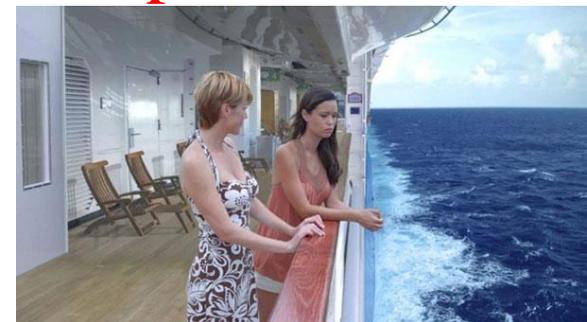


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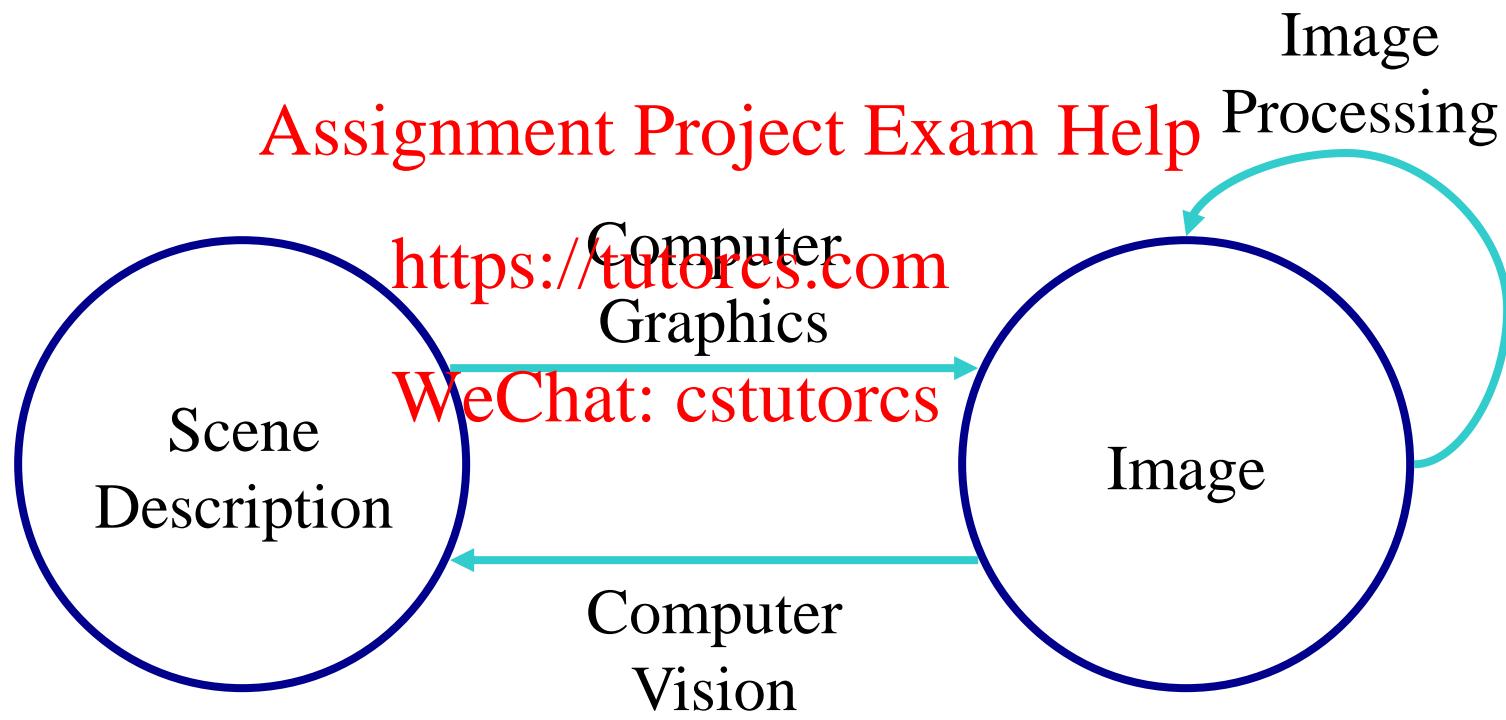
Luminance
Channel

Computer Graphics

- Study methods for digitally synthesizing and manipulating **visual content** and the **generation of 2D images** for display
- Although it **Assignment Project Exam Help**, it also studies 2D computer graphics and certain **image processing** (e.g. texture map creation) <https://tutorcs.com>



Relationship with Other Subject Areas



Old Days: Graphics = Image Processing

CPU processing was sufficient for getting the contents to display (render) properly.



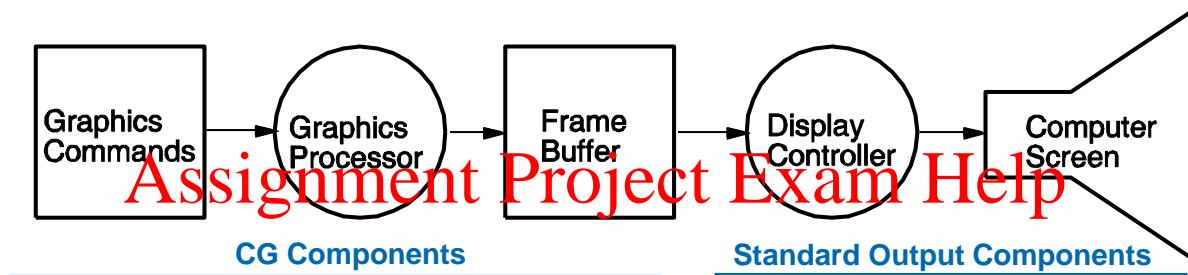
Lode Runner 1983



Namco 1980

Modern Graphics Hardware Setting

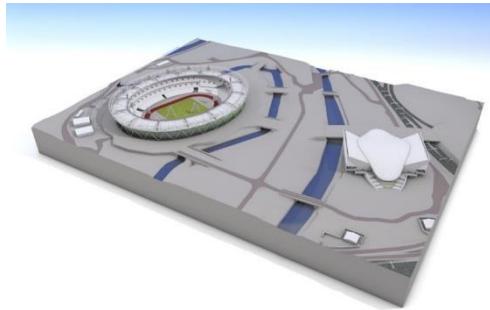
General Graphics System:



- Typically, the CPU runs graphics applications, e.g., a computer game, and continuously generates graphics commands.
- These graphics commands, e.g., draw polygons, draw game characters, are sent to the graphics system.
- They are buffered and executed by the graphics processor one at a time.

Modern Graphics Processor: GPU

- A GPU (Graphics Processing Unit) is tailored for highly parallel operation while a CPU executes programs serially

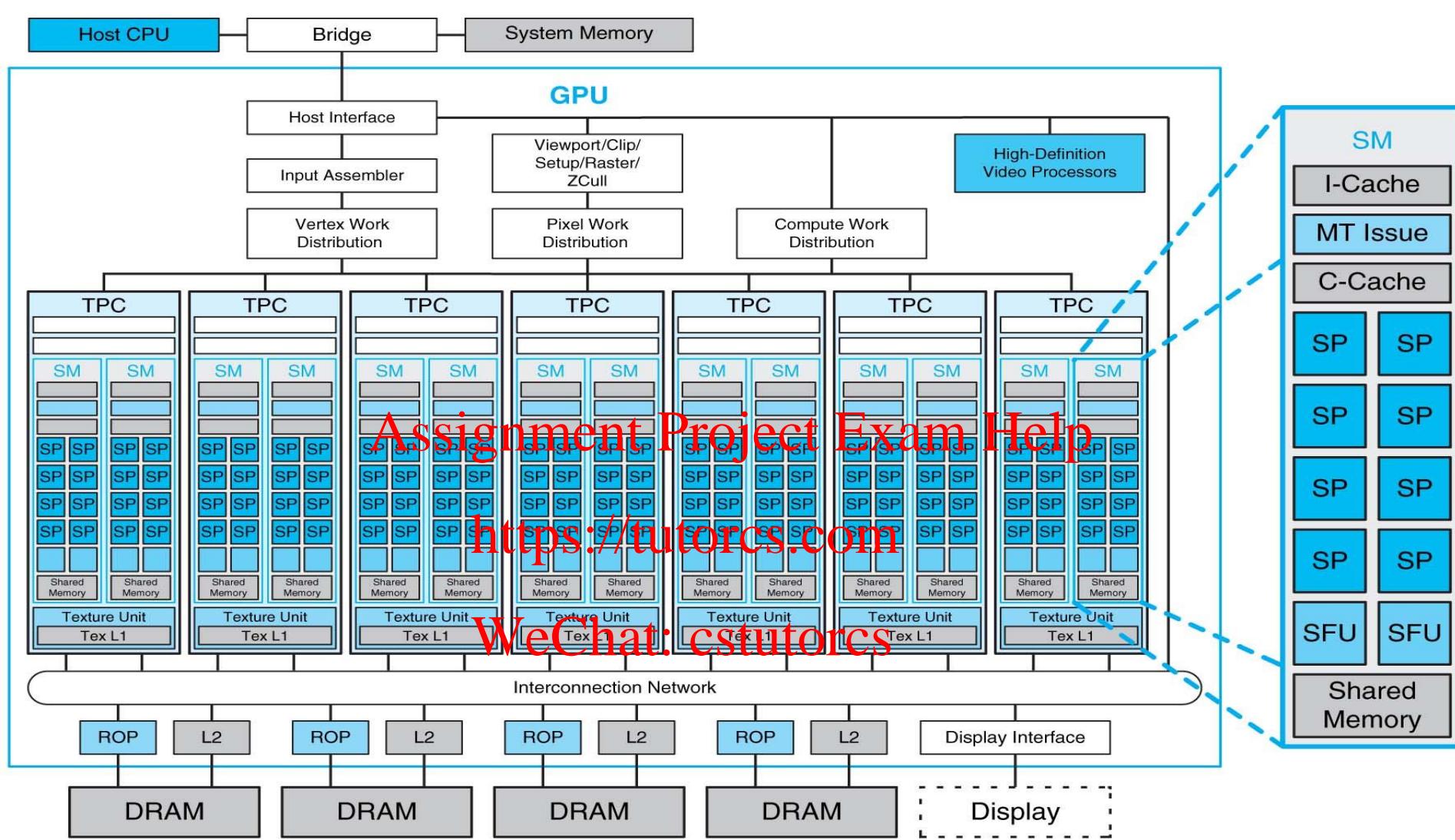


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Basic unified GPU architecture. Example GPU with 112 streaming processor (SP) cores organized in 14 streaming multiprocessors (SMs); the cores are highly multithreaded. It has the basic Tesla architecture of an NVIDIA GeForce 8800. The processors connect with four 64-bit-wide DRAM partitions via an interconnection network. Each SM has eight SP cores, two special function units (SFUs), instruction and constant caches, a multithreaded instruction unit, and a shared memory. Copyright © 2009 Elsevier, Inc. All rights reserved.

Graphics Processor

- A graphics processor accepts graphics commands from the CPU and executes them.
- Graphics commands may include:
 - Draw point
 - Draw polygon
 - Draw text
 - Clear frame buffer
 - Change drawing color
- It draws rendered results into the frame buffer.

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• Draw point

• Draw polygon <https://tutorcs.com>

• Draw text

• Clear frame buffer

• Change drawing color

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*Commands are
kept simple and
generic, but NOT
complicated and
specific!!*



Draw dinosaur
Draw Ginger man
Draw Duck

Types of Graphics Commands

A graphics processor handles two types of drawing commands.

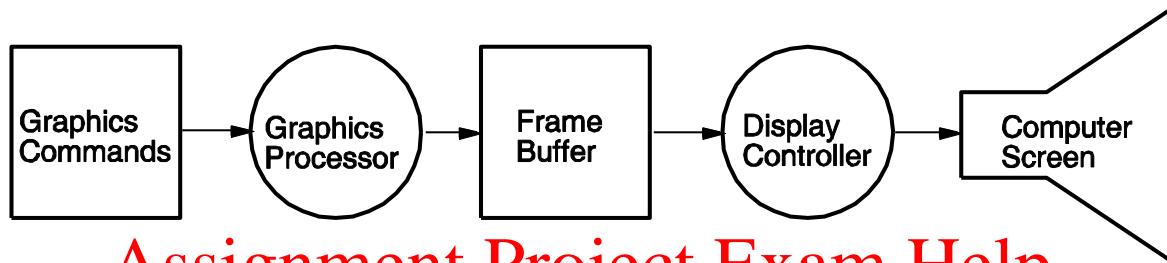
2D graphics commands:

- Based on 2D coordinates (i.e., x and y).
- When objects overlap each other in x and y , the current object being drawn will obscure objects drawn previously.
- Frame buffer operations, such as copy/move/clear contents.

3D graphics commands:

- Based on 3D coordinates (i.e., x , y and z).
- When objects overlap each other in x and y , the z values of the object determine their visibility.

Frame Buffer



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- **Frame buffer:** a memory space that stores a grid.
- Each grid cell stores an intensity or color value and is mapped to a pixel on the screen.
- **Double buffering:** To support interactive graphics applications, more than one frame buffer is required. While an image in the frame buffer is being displayed, the next image can be rendered into the other frame buffer.

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Stereoscopic Vision (Stereopsis)

- Stereopsis – “Solid Sight” is the impression of depth that is perceived when a scene is viewed with both eyes
- Two Eyes
 - Interocular Distance(~2.5”)
 - Two Views <https://tutorcs.com>
- Retinal Disparity
 - Fusion - Singleness of vision
- Application: Immersive VR
 - Google VR (Cardboard)
<https://vr.google.com/cardboard/>



Graphics Modelling and Programming Tools

➤ Modelling Packages

- 3D studio MAX, Maya, Blender
[3D object modeling, 3D environment construction]

➤ Image creation and manipulation

- Photoshop, <https://tutorcs.com>

➤ Programming Toolkits

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- OpenGL, WebGL (Khronos group)
- DirectX (Microsoft)
- Unreal Engine (Epic Games): Game Engine [Visual Effects, Terrain construction, Animation, AI, etc.]

Reading List

- ***Computer Graphics with OpenGL***

D. Hearn and M. Baker, Prentice-Hall.

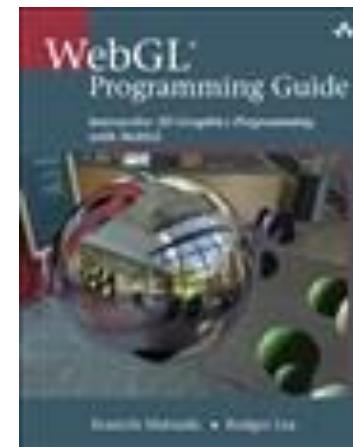


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- ***WebGL Programming Guide***

Kouichi Matsuda / Rodger Lea, Addison Wesley.

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Reference

- **Computer Graphics with Open GL
[Chapter 1]**

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Applications of Computer Graphics

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Product Design and Simulation



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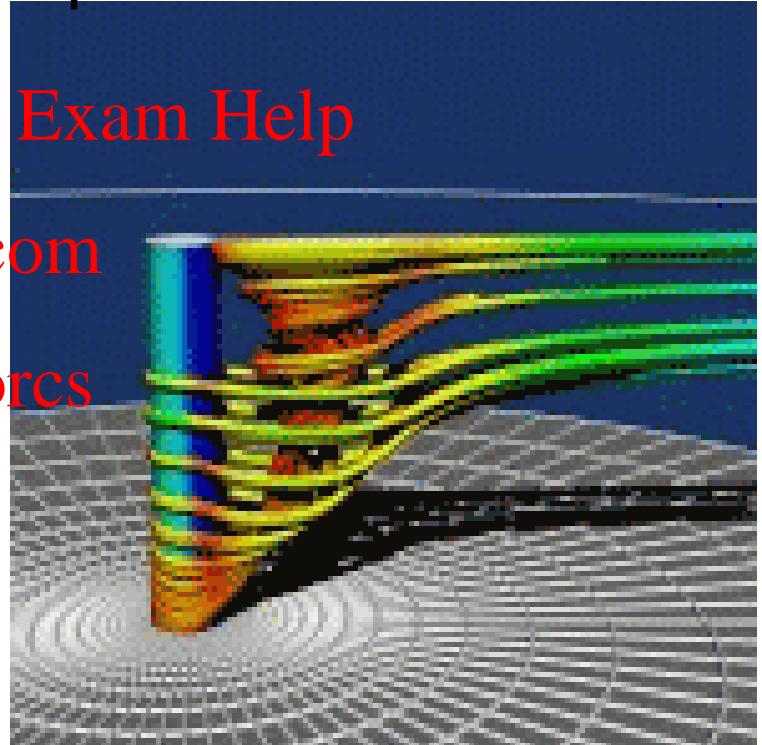
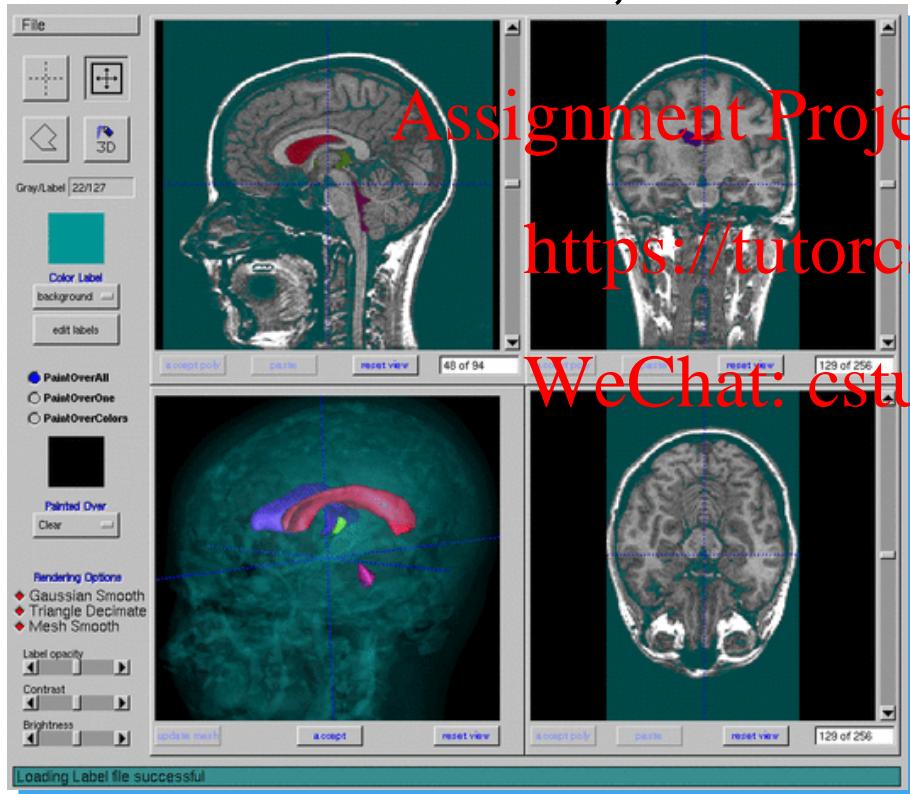


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Applications - Visualization

- Model acquisition, modelling, physical simulation, user interaction, Information presentation



Applications - Movies

- Modelling, animation, visual effect, visual quality



Inspector Gadget © 1999 Walt Disney Pictures
Visual Effects by Dream Quest Images.

Applications - Games

- Modelling, animation, visual effect, performance, user interaction and (networked) collaboration, response time

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