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Topi Graphics

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Goals of Computer Graphics

- To use computer and mathematical techniques to build a virtual, real-like 3D world, animated by time changes, inside the computer
- To study techniques th der the virtual 3D world to real- ages and movies

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Movie Industry Applications

Different kinds of “CG” movies

- Type I: Created entirely Using CG

  e.g. ”Fozen 2”

- Type 2: Real p

  e.g. “Distric

- Type 3: CG Movie + Real Pe

  e.g. “Space Battleship Ya

- Type 4: Conventional movie with CG special effects

  e.g. “Initial D” (production documentary)

- Type 5: “3D Movies”

  e.g. “Avatar”

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Game Industry Applications

- Mobile phone games (i-phone apps, android …)
- Playstation (PS, Nintendo, Sega …)
- PC Single Person games (Single player and multiple player)
- Hand held games
- Web games
- Motion control
- …

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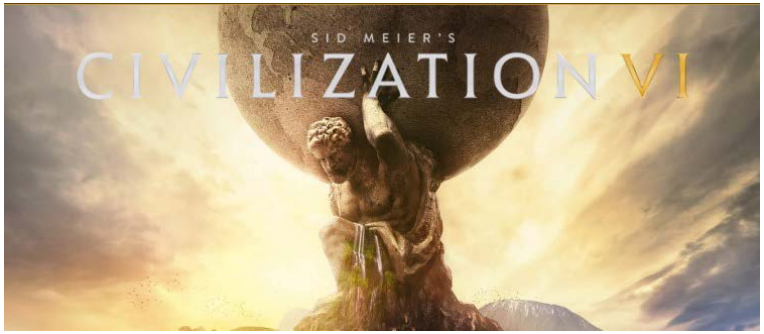

Advertising Industry Applications

- Commercials in TV

  e.g. TVB Jade
- animations in web page

  e.g. South C

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Design Industry Applications

- Computer Aided Design (CAD)

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Virtual Reality Industry Application

- VR creates an immersive environment such that the user has the false but real sensation of bei artificially creat
- Applications in games, medical therapy, visualization, design, surgery practice, teaching, …

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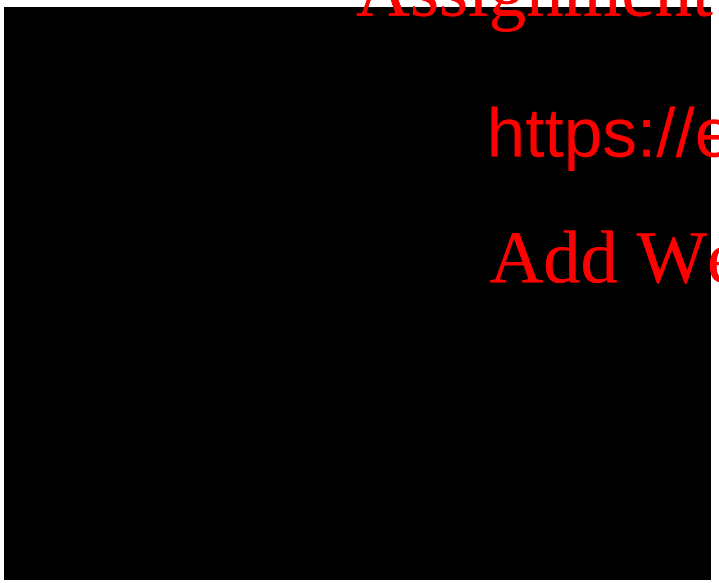
Other less well known Applications

- Visualization

  Visualize mathematical problems



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U LE? The Collatz Conjecture

Goldbach's Conjecture

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Worldwide air transportation network

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A global genetic interaction network maps a wiring diagram of cellular function

- Training
  - flight simulator
  - car simulato
  - spaceship c
  - …

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- Education
  - animated story book
  - animated presentation

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Electronic books for children

- Computer Art
  - new type of painting
  - New type o art form
  - …

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“Butterfly 6228” Author: Human and Computer

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Full-body anime generation with Generative Adversarial Nets (GAN)

Converting movie to cartoon and vice versa

- Movie to cartoon
- Cartoon to movie

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Comic H2

CG in Hong Kong

- CG forum

  http://www.cgvigual.com/forum/index.php

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Course Aim

- The aim of this course is to provide students with an understanding of the basic principles, concepts, and techniques of computer graphics fro iewpoint.

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CILOS

- (CILO1) Apply 3D object representation techniques to build up a graphics scene
- (CILO2) Model and view articulated objects by hierarchical structuring techniques and coordinate transform
- (CILO3) Ap d rasterization techniques t
- (CILO4) Apply texture ma animation techniques to create a movie
- (CILO5) Apply and evaluate advanced graphics techniques
- (CILO6) Create an animation or a game using computer graphics

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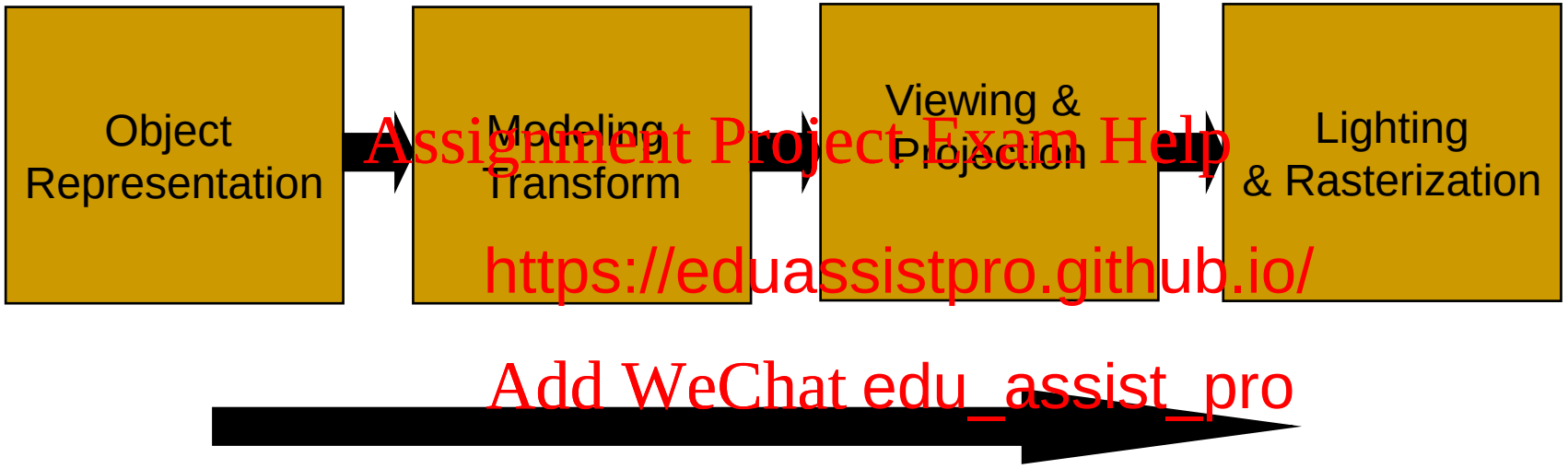
Course Content



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Object Representation (CILO1)

Lecture 2

- How to construct simple objects such as spheres, cones, boxes ...

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Modeling Transform (CILO2)

Lecture 3

- how to move the simple objects around, rotate them, scale them, reflect them, ...

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Lecture 4

- introduce the idea of local system, and how to use the concepts to buil coherent moving object by using the hierarchy concept

Viewing and Projection Transform (CILO2)

Lecture 5

- how to put the camera in a desired configuration within the graphics scene and
- how to use d ject a 2D image on the came different projection effect that can be achieved

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Lighting and Rasterization (CILO3)

Lecture 7

- how to create light sources, shading and colour

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Lecture 8

- how to elimi

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Lecture 9

- how to create realistic shadows

Animation (CILO4)

Lecture 6

- how to animate the images to create a smooth flowing movie

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Advanced Graphics Techniques (CILO5)

Lecture 10

- How to create more realistic graphics by texture mapping

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Lecture 11

- Sample of advanced techn

OpenGL Mini Project (CILO6)

- This course uses the open source de facto industry standard: OpenGL, It is a C/C++ library that allows C programmers to write programs that directly access graphics hardware
- The gl and glut

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- How to learn OpenGL
  a) Learn during lecture, tutorial and mini project
  b) Search the web for the command
  c) OpenGL Function Index at the end of the text

Other forms of OpenGL

- Fixed function OpenGL is taught in this course first as it is the best for beginners. There are other forms of OpenGL

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- WebGL - Ope ular
- OpenGL ES is used in iphon

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- OpenGL shading language (ed nowadays

Relationship of this course with commercial software

- Commercial software e.g. 3D studio

  used by game developers, many TV commercial studios and architectural visualization studios, movie effects etc.

- This course giv owhow behind the techniques in t
  - You can use them more sensibl
  - You know the limitations of thes d why
  - You acquire the background for more advanced state of the art knowledge (e.g. SIGGRAPH is the premier conference in CG)
  - You can create a new special effect not supported by the software or research your own novel effect
  - OpenGL is also a popular tool

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Text Book and References

- Text book:

  Computer Graphics with OpenGL, Hearn and Baker, 4th Ed. (2011) Pearson (ISBN 10: 0-13-248457-9)

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- Course Reserve has four copies. To access Course Reserve, go to CityU Library and
- Course Reserve material.

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entary reference

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Assessment and Schedule

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Coursework Components (50%)

Time	Item	Scope	Percentage
Tests			
Wk 6 (24 Feb.)	**Test 1**	everything taught in Wk 1-5	15%
Wk 11 (31 Mar.)			15%
Wk 13 (21 Apr.)	**Mini-Project**		12.5%
	Other Assignments (at least 2)		5%
Wk 8 (10 Mar.)	**Mini-Project Progress**		2.5%

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Guideline for mitigation request

- Departmental guideline: “For course assessment **work with weighting less than 20%** such as short quiz, test, etc., **make-up assessment will not be provided** to students. The students will score “0” fo cerned.”
- According to thi sessment will be provided

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Mini-project progress

- Hand in mini-project progress with
  - Realistic hierarchical structures
  - Realistic animation
- See mini proje
- No need to ha
- Hand in through Canvas. It w d for hand in

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Grade distribution 19/20

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If you have questions

- Please email me your questions during the week.
- We can also chat using Zoom. Please let me know when you would be available.

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Teaching Assistant

Ms. LIU Wenwen

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Office: FYW2386 Tel: 3442 9845

Email: wenwen.liu@my.cityu.edu.hk

Please email/phone to book an appointment

Mathematical Background

- You should have the mathematical background below:
  - 3D coordinate systems in Euclidean coordinates and polar coordinates
  - Basic matrix and vector arithmetic
  - Calculation of
  - Scalar (dot) pr its physical meanings
  - Vector (cross) d its physical meanings
  - Concepts of partial derivatives
- Please consult any standard text in Linear Algebra

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Non-standard mathematical notation used

- **|N|** is normally used to denote the magnitude of vector **N** and is a scalar. In this course, **|N|** is sometimes also used to denote "normalise to a unit vector"

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e.g. The light source is at (3, 3, 3), the surface point is at (0, 0, 0). The unit light vector is

$$L = |(3,3,3) - (0,0,0)| = \left(\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}\right)$$