

Graphics and Visualisation

EE563

<http://www.eeng.dcu.ie/~ee563>

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Introduction

Module Aims:

- This course examines scientific visualisation and the visualisation process from an engineering perspective
- Topics to be examined include:
 - An introduction to computer graphics (2-D & 3-D)
 - Volume and surface visualisation
 - Computer graphics frameworks
 - Real-time visualisation techniques
 - Acquisition and visualisation systems

Introduction

Module Aims:

- The module aims to provide an evolving up-to-date snapshot of leading edge visualisation methodologies and techniques, focusing on research literature
- The course will emphasis a practical approach through assessments and a computer based examination process
- **Prerequisite(s)**
 - Object Oriented Programming (EE553)

Introduction

Module Assessment

- This module will be assessed using a combination of practical assignments and terminal examination
 - **Assignment 1:** 10%
 - Week 5 (provisional)
 - **Assignment 2:** 15%
 - Week 9 (provisional)
 - **End of module exam:** 75%

Introduction

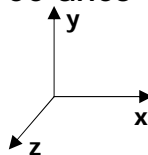
Indicative Syllabus

- Mathematical Fundamentals of Computer Graphics
- Concepts in 3-D graphics
- Rendering Techniques
- The Graphics Pipeline
- Scene Graph Theory
- Real-Time Rendering
- Computer Animation
- Visualisation Systems and Technologies

Introduction

What is 3D Computer Graphics?

- This course deals primarily with 3D graphics programming
- 3D computer graphics is the displayed representation of a scene or an object that appears to have three axes of reference
 - Width
 - Height
 - Depth(x, y and z in Cartesian Space)



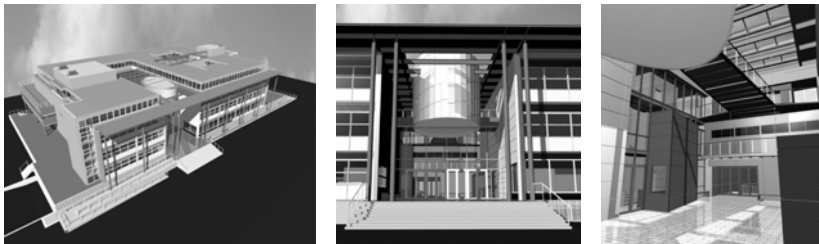
Introduction

Why learn about 3D computer graphics?

- Our environment (space) is essentially three dimensional
- Applications in a wide variety of disciplines
 - Medicine
 - Entertainment Industry
 - Etc...
- Hardware capable of generating 3D computer graphics is now readily available
 - Reasonably fast
 - Affordable

Applications

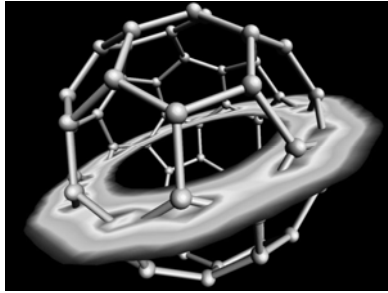
Architecture – Computer Modelling



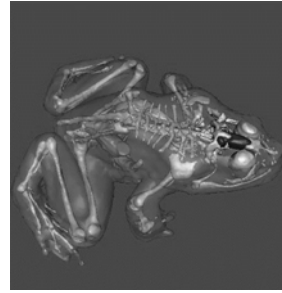
- An alternative to conventional card models
- Computer models can be automatically generated from CAD drawings

Applications

Scientific Visualisation



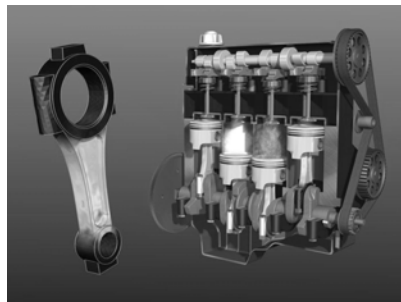
- Computer Aided Chemistry
 - Visualisation of a of carbon-60 molecule
 - 2D slice represents electron density



- Virtual Anatomy
 - Alternative to dissection for teaching purposes

Applications

Computer Aided Engineering



- Computer modelling and simulation in industrial project development

Applications

Entertainment Industry: Movies

The Lord of the Rings – Gollum/Andy Serkis



- State if the art motion capture and rendering
- Body movement and facial expressions captured simultaneously

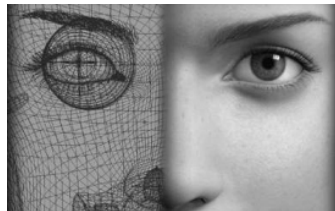


Applications

Entertainment Industry: Movies

Final Fantasy – Dr Aki Ross

- Completely computer generated movie



- This character's hair took 1/3 the rendering time for the entire film
- Film Cost \$145M
- Each strand was modelled separately



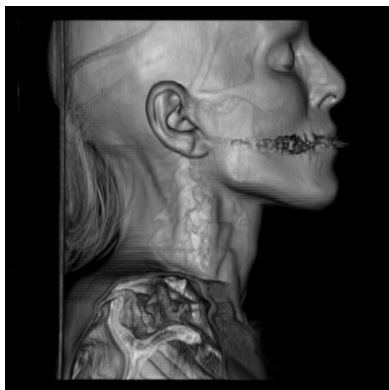
Applications

Medical Imaging

- Images/volumes acquired using:
 - Computed Tomography (CT)
 - Magnetic Resonance Imaging (MRI)
 - Positron Emission Tomography (PET)
 - Ultrasound
- 2D, 3D and 4D data
- Can be used for screening and preoperative evaluation
 - Avoid invasive procedures and surgery

Applications

Medical Imaging - Head CT



- Complete volumetric model of the head and upper torso
- Using image processing we can segment regions of interest

Applications

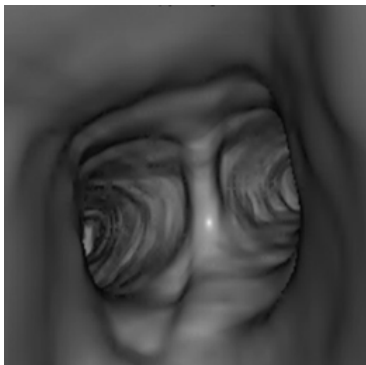
Medical Imaging - Abdominal CT



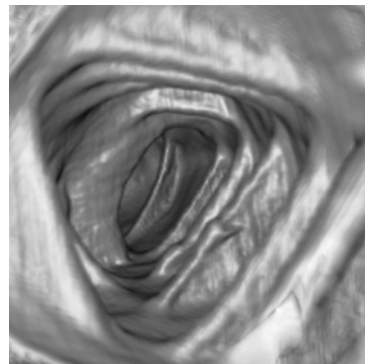
- Volume generated from 2D slices
- CT Data is monochrome
 - Grey level relates to material density
- Pseudo Colouring used to highlight different regions and provide a more realistic image
 - Pelvis
 - Rib cage
 - Kidneys
 - Etc...

Applications

Medical Imaging - Virtual Endoscopy



- Virtual Bronchoscopy
 - Monitoring disorders of the lungs and respiratory tract



- Virtual Colonoscopy
 - Primarily used for cancer screening

Note:

- All of the course material for this module can be accessed at:
 - <http://www.eeng.dcu.ie/~ee563>
 - You will need your DCU user name and password to access the notes for this module