PART B: VISUAL COMPUTING

Introductory Lecture

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LECTURER DETAILS

John Dingliana
GV2: Graphics Vision and Visualization Group [gv2.scs.tcd.ie]
School of Computer Science & Statistics
Location (From October 3):
TCD Center for Creative Technologies
Stack B, IFSC
Email: John.Dingliana@scss.tcd.ie

Module Webpage:
http://www.scs.tcd.ie/John.Dingliana/cs7029

MODULE OBJECTIVES

Explore the technology underlying Computer Images
- How this is applied to advanced areas such as geometric modelling, rendering and animation

Explore digital images as a medium.
- Discuss digital modes of input and output – and the limitations/potentials of graphical digital media

Appreciate the production processes, complexity, tools and issues involved in producing 2D/3D digital media

LEARNING OUTCOMES

On successful completion of this module, students shall be able to:

1. Identify theoretical principles and techniques underlying modern graphical applications, including the hardware and low-level software used in such systems.
2. Discuss how low-level fundamental components common to all computer applications come together to produce high-level computer imagery in digital media.
3. Generate three-dimensional (3D) environments using a scene-definition tool and render images of these using a photo-realistic 3D rendering tool.
4. Display on industry-standard computer aided tool to create 3D objects and models, modify a virtual camera, animate and render images and videos of complex virtual scene.
5. Write computer programs for modifying computer images and generating graphical objects in 2D and 3D.
6. Implement an interactive computer application, that handles input events from the user (such as mouse, keyboard input) to effect graphical output.

MODULE STRUCTURE (PART B ONLY)

Classes each week on Monday 11am-1pm.

Note Lecture Swap – week 2 and 3
- No CS7029 lecture in Week 2 (3rd October)
- Two lectures in Week 3: Mon 10 Oct 11-1 AND Tues 11 Oct 11-1

Normally 1 hour of lecture followed by 1 hour of labs

POV-Ray
- 3D modelling (bottom-up), rendering (top-down)

3D Studio Max
- 3D modelling, rendering, animation

Processing
- Image processing, interaction, graphical programming, multi-media
WHAT IS A COMPUTER IMAGE?
Understanding the problem domain

IMAGES: DEFINITION

Image – (noun)
1. a physical likeness or representation of a person, animal, or thing, photographed, painted, sculptured, or otherwise made visible.
2. an optical counterpart or appearance of an object, as is produced by reflection from a mirror, refraction by a lens, or the passage of luminous rays through a small aperture and their reception on a surface.
3. a mental representation; idea; conception.
4. Psychology; a mental representation of something previously perceived, in the absence of the original stimulus.
5. form; appearance; semblance: We are all created in God’s image.
6. counterpart; copy: That child is the image of his mother.
7. a symbol; emblem.
... 
14. Archaic. an illusion or apparition.

DIGITAL IMAGES

An image is a visual output of data stored in terms of numeric, recordable elements.
Most digital images we use today are output as a regular grid of pixels, referred to as a raster.
Intermediately the image can be stored in the form of lines, curves and filled areas, referred to as vector primitives (objects).
All of these are represented by (whole) numbers: i.e. digital.

RASTER AND VECTOR REPRESENTATIONS

Digital Image Processing is the act of recording and modifying data used in generating the images.
This could be done in different ways...

Manually: where the user specifies each colour
Procedurally: where a sequence of steps is defined that generates an image
SOME RELATED AREAS

Image Processing → Concepts → Modelling → Rendering → Data / Models → Images → Computer Vision → Image Acquisition → Real World

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THE GRAPHICS PROCESS

The process of creating/modifying digital images.

- Discrete
- Digital
- Representations

COMPUTER GENERATED IMAGERY

The computer graphics process

COMPUTER GRAPHICS

The core technological issues in computer generated imagery.
MODELLING

MODELS (in computer graphics): A Digital, Descriptive or Mathematical representation of a scene or object that can be stored (efficiently) in computer memory.

MODELLING

Modelling for most practical users implies authoring 3D content. In this module we are interested in more than this.

MODELLING ISSUES

Conversion of geometric data for Digital Storage
- Uniqueness of representation
- Efficiency
- Correctness
- Fidelity/Resolution?

Consider final use of model and how it is to be rendered

RESOLUTION AND MODELING
TYPES OF MODELS

The rendered IMAGE is a visual representation of the model on digital output media.

A single model might be represented in many different ways.

3D INFORMATION ON A 2D DISPLAY
- Projection
- Viewing
- Hidden Surface Removal
- Lighting

LOW-LEVEL ISSUES
- Line Drawing
- Clipping
- Polygon Filling
- Curves
-Rasterization
- Discretization.
**IMAGE PROCESSING**

Operations on Images

**ANIMATION**

Remodel and Re-render

**USER INTERFACES**

A more modern "console"

**GRAPHICAL USER INTERFACES (GUI)**

Different types of images in different modes
- **IMMERSIVE VIRTUAL REALITY**

- **AUGMENTED REALITY**

- **IMAGE SYNTHESIS**

- **COMPUTER ANIMATION**

- **VISUAL EFFECTS**
- **VISUAL EFFECTS**
  - CGI replacing reality

- **AIDING TRADITIONAL ANIMATION**
  - Aiding Traditional Animation

- **ABSTRACT IMAGERY**
  - Abstract Imagery

- **ABSTRACT ANIMATION**
  - Abstract Animation

- **SIMULATING HUMAN EXPRESSION**
  - Simulating Human Expression
IMAGE ABSTRACTION

VIDEO ABSTRACTION

ANIMATION CONTROL

INTERACTIVE VIRTUAL ENVIRONMENTS

CULTURAL HERITAGE

Cultural Visualisation and Virtual Restoration
APPEARANCE MODELLING

LIGHTING AND LAYOUT DESIGN

CGI – DEGREES OF ADOPTION

Passive Viewers
- Data: Images, Video

Interactive User
- Interactive Applications: e.g. games, simulators, VR

Creative Author
- Tools: Digital Artists, 3D Modellers

Developer
- Graphical software: scripts, code, math equations, bits and bytes

Engineer
- Graphics hardware: input/output devices, boards and circuits

MODULE TOPICS

How digital images are stored and displayed
3D OBJECT MODELS

Representing shape

- Basic mathematical principles used in computer graphics
- 2D and 3D Modelling data structures
- Modelling operations

MATERIAL PROPERTIES

- Colour
- Texture
- Relief and micro-geometry

LIGHTING

Simulating Light Material Interaction

- Lighting Cues for Conveying 3D shape

REALISTIC RENDERING

- Image Synthesis
- Global Illumination
- Ray-tracing

3D MODELLING IN PRACTICE

Computer aided 3D Modelling Tools

- Shape Modelling
- Texturing
- Animation

SCENE MODELLING

- Modelling Transforms
  - Translate
  - Rotate
  - Scale
- Scene and Modelling
RECOMMENDED BOOKS

The course won't be based on a particular textbook. However the following two books are good reading ... if you can get your hands on them:

- The Computer in the Visual Arts, Anne Morgan Spalter. ([US])

ALTERNATIVE TEXTS

The following are roughly equivalent and cover the technical aspects of the course but are designed for Computer Science Students:


IMAGE PROCESSING


Some-what Technical (math and computing)

PROCESSING [PROCESSING.ORG]


Processing: Creative Coding and Computational Art – Ira Greenberg

ASSIGNMENT 1: INTRODUCE YOURSELF

Worth 1% of cs7029 part B.

- Due Monday 3rd October, 2016. Write about 2 paragraphs (max 300 words)
- What is your background? Please detail any previous experience in:
  - programming
  - mathematics
  - 3D modeling tools + 2D graphical tools
- What do you expect from this module? What do you think a better understanding of images and computer graphics will enable you to do?

- Submit through mymodule.tcd.ie [use this to test if it is working]
- OR email it (in word or text format) to John.Dingliana@scss.tcd.ie
- With Subject field to include: “cs7029 - Assignment 1”