Overview

Computer graphics is the art and science of representing and manipulating information using images generated through computation. This involves the study of (i) models suitable for manipulating and viewing shapes, (ii) real-time and realistic rendering techniques for these models, and (iii) devices for viewing and interacting with the models.

This module offers an introduction to the fundamental concepts, techniques and tools in computer graphics. It introduces the basic functionality of graphics devices and investigates the principles and techniques for representing, creating, manipulating and analysing 2D and 3D shapes. In particular it focuses on techniques for representing 3D objects and scenes and creating real-time and realistic images of 3D scenes.

It requires good mathematical ability in particular in linear algebra, affine geometry and some calculus and good programming skills and an understanding of data structures (mainly trees and graphs) and algorithms.

The module consists of the following sections:

I. Graphics Hardware: graphics systems, display devices, input devices, graphics processors

II. Geometric Modelling: object representation, scene representation, transformations, illumination models, curves and surfaces, free-form surfaces, convex hull finding algorithms

III. Real-Time Rendering: viewing, clipping, visible-surface detection, line drawing, polygon drawing, polygon shading

IV. Realistic Rendering: texture mapping, ray tracing, radiosity, amorphous objects, physically based modelling, photon tracing

Recommended Literature

Any one of the following books is suitable as a general text book for this module. They all cover, in slightly different approaches, the material. Older editions are usually fine as well, but may cover less.

- D. Hearn, M. Baker. Computer Graphics with OpenGL, 3rd Edition. Pearson Prentice Hall, 2003.
- E. Angel. Interactive Computer Graphics, 4th Edition. Addison Wesley, 2005.
- M. Slater, A. Steed, Y. Chrysanthou. Computer Graphics and Virtual Environments: From Realism to Real-Time. Addison Wesley, 2001.

Background Reading

More specific books on OpenGL programming, more mathematical approaches towards graphics, specific topics or simply alternative books to those above:

- D. Shreiner, M. Woo, J. Neider, T. Davis. OpenGL Programming Guide: The Official Guide to Learning OpenGL, Version 2, 5th Edition. Addison Wesley, 2006.
- OpenGL Reference Manual: The Official Reference Document to OpenGL, Version 1.4, Addison Wesley, 2004.
- E. Angel. OpenGL: A Primer, Addison Wesley, 2002.
- R. J. Rost. OpenGL Shading Language, Addison Wesley, 2004.
- S. R. Buss. 3-D Computer Graphics, A Mathematical Introduction with OpenGL, Cambridge University Press, 2003.
- M. Pharr, G. Humphreys. Physically Based Rendering: From Theory to Implementation. Morgan Kaufmann, 2004.
- H. W. Jensen. Realistic Image Synthesis Using Photon Mapping, A. K. Peters, 2001.
- F. S. Hill, Jr. Computer Graphics Using OpenGL, 2nd Edition. Prentice Hall, 2001.
- J. D. Foley, et al. Computer Graphics, Principles and Practice in C. Addison Wesley, 1995.

WWW Sites

The module has a web-site with notes, exercises, past exams, etc. at

http://www.langbein.org/teaching/graphics/

Please note that this site is updated regularly and the material may change any time. Material will also be available on Cardiff University's blackboard site at http://blackboard.cf.ac.uk/. There are plenty of graphics resources on the web and google is a good place to start. The following sites are just some suggestions: http://www.opengl.org/, https://jogl.dev.java.net/, http://www.mesa3d.org/, http://www.siggraph.org/.

Programming Environment

You can use any language on any platform to implement algorithms, etc. (in particular for the coursework). But you have to use the OpenGL graphics API. Suitable languages are Java, C and C++, but any language with an OpenGL interface is accepted. You are also free to choose any operating system platform such as Linux, Windows or MacOS, but for the coursework it is required that your program runs on at least one computer at the School of Computer Science. The emphasis of the module is on the concepts behind the algorithms and data structures and your work will be evaluated based on the suitability of the abstract data-structures and algorithms you employ, the way they are implemented in your chosen programming language and the way you use OpenGL.

Programs discussed in the module, etc. are written for Linux (but may work on other platforms) in C/C++ and Java using gcc 4 and OpenGL.

OpenGL

The basics about OpenGL and the underlying concepts will be discussed in class, but you are expected to spend some time outside class to become familiar with the more practical aspects of using OpenGL. The lab classes of this module are intended to help you with this.

Exercises

For each section of the module there will be exercise sheets which will be discussed in the tutorials. You are expected to work on these exercises before the tutorials, such that you can answer questions about the exercises, discuss the topics and ask question about what you did not understand, etc. You will also have the opportunity to present your solution to some of the exercises. This is highly recommended for exam preparation as the exercise sheets contain questions similar to exam questions.

Coursework and Exam

There is one piece of coursework for this module which requires the iplementation of a graphics related program using OpenGL. Hand-out is in week 4 and hand-in in week 11. The coursework is worth 25% of the total marks.

There is also a two hour written exam worth 75% of the total marks.