MECA2170 Mechanical computer-aided design.

[30h+30h exercises] 5 credits

This course is taught in the 1st semester

Teacher(s): Vincent Legat
Language: French
Level: Second cycle

Aims

The aim of this lecture is to introduce students to the principles and practice of computational geometry. Both theoretical issues and industrial applications will be presented in order to be able to solve some new problems arising a several fields : robotics, pattern recognition, geography, mechanical manufacturing...

Main themes

On completion of the course the students should
- have a basic understanding of computational modelling issues and what can be achieved through its use,
- be aware of the complexity of some problems, including selection of algorithms,
- have a basic knowledge of computer graphics,
- be able to code small code with OpenGL,
- be aware of the range of applications of computational geometry.

Content and teaching methods

Computational Geometry is a relatively new field concerned with designing algorithms and computer programs to perform geometric computations. A need for such computations arises in many fields: computer graphics, robotics, pattern recognition, geography, manufacturing, and so on.
An example is the following problem that arises in medical imaging.
From a CAT or MRI scan, slices through a three-dimensional object are obtained, perhaps a brain tumor. From these slices the object must be "reconstructed." The basic step of this reconstruction is connecting two polygons lying in parallel planes. The connection is effected by finding a collection of triangles that span the two planes, have their corners at vertices of the polygons, and fit together seamlessly to form a closed polyhedron. This basic problem of reconstructing a polyhedron from two parallel polygonal slices has been heavily studied due to its importance, but no completely satisfactory algorithm has been found" (J O'Rourke)
As the objective of this course is to give the student a quick overview in the problems of computational geometry, modelling and design, the content of the course is as follows:
- Polygons triangulations and partitions,
- Convex hulls in 2D and 3D
- Voronoi diagrams and Delaunay triangulations
- Infography and interactive computer graphics with OpenGL.
- Solid modelling through Bezier and NURBS curves or surfaces.

In addition, a specific variable topic is selected and analyzed.

Other information (prerequisite, evaluation (assessment methods), course materials recommended readings, ...)

- J. O'Rourke, Computational Geometry in C, Cambridge University Press, (1988).
- J.D. Foley, A. van Dam, S.K. Feiner, J.F. Hughes, Computer Graphics : Principles and Practice, Addison Wesley, (1997).
- E. Angel, Interactive Computer Graphics : a top down approach with OpenGL, 3rd edition (2002).
- P. Bezier, Mathématiques et CAO 4 : Courbes et surfaces, Hermes, (1986).
- R.H. Bartels, J.C. Beatty, B.A. Barsky, An Introduction to Splines for use in Computer Graphics and Geometric Modeling, Morgan Kaufman, (1987).
- D.D. Bedworth, M.R. Henderson, P.M. Wolfe, Computer-Integrated Design and Manufacturing, McGraw Hill, (1991).
More information and grading policy is available on the web-site http://www.mema.ucl.ac.be/~vl/teaching/meca2170/
Students will use MATLAB, C and OpenGL to explore the basic principles of the computational geometry and computer graphics.

Other credits in programs

MAP23	Troisième année du programme conduisant au grade d'ingénieur civil en mathématiques appliquées	(5 credits)
MECA22	Deuxième année du programme conduisant au grade d'ingénieur civil mécanicien	(5 credits)
MECA23	Troisième année du programme conduisant au grade d'ingénieur civil mécanicien	(5 credits)