Abstract

Traditionally, this course has had an emphasis on geometric modeling and its applications in CAD/CAM in relation to shape design. Therefore, topics on curves and surfaces representation, manipulation, and their rendering were abundant. However, the emphasis in the current version of the class would be on presenting a unifying treatment for the design of not only shapes, but also motions of entities, such as lines, planes, and rigid bodies, and thereby, making it far more interesting for Mechanical Engineering graduate students. In that regard, perhaps, the title of this class should really be "Algorithmic Geometry and Computation: From Shape to Motion Design", for this title clearly illustrates an emphasis on the algorithmic design of motion of entities from a point to a rigid body. It will be shown that in the language of projective geometry, one can design curves, surface, and motions utilizing same algorithms and similar data structures. In the process, the students will learn the theory of NURBS (Non-Uniform Rational B-splines), which is the dominant representation standard in existing CAD/CAM system, and extend it to the space of rigid body displacements for the design of motions.

Topics

The following is a tentative list of topics that I plan to cover. Some topics and their order may be changed at the instructor’s discretion on account of time constraints or interest shown by the class.

1: Geometry of Fundamental Constructs

   1.1 Points and Vectors
   1.2 Affine coordinates and combinations
   1.3 Affine and Linear Transformation
   1.4 Homogeneous Coordinates: Points, Lines, and Planes
   1.5 Projective Duality
   1.6 Multivector Algebra

2: Bezier and B-spline Representation and Modeling

   2.1 Implicit and Parametric Forms
   2.2 Bezier representation
   2.3 B-spline representation
   2.4 Rational Bezier and B-spline representation
   2.5 Beyond NURBS representation
3: Geometry of Rigid Body Displacements

3.1 Displacement Representation and Kinematic Mapping: Quaternions, Dual Quaternions, and Bi-quaternions
3.2 Image Space of Planar, Spherical, and Spatial Kinematics

4: Geometry of Free-form Motions

4.1 One- and Two-Parameter Rational Motions
4.1 Control Position Modification
4.1 Dual Weights
4.1 Constraint-Based Motion Modification

5: Geometric-Kinematic Algorithms

5.1 Distance metric for displacements
5.1 Convex Hull of displacements
5.1 Application to Collision Prediction

Lecture: 6:50-9:50 PM Monday (Chemistry 128)

References:


Website: http://blackboard.stonybrook.edu

Grading: Homework 50%, Projects and Term Paper 50%

Homework: Homework will be either assigned in the class or posted at blackboard. You can access Blackboard at: http://blackboard.sunysb.edu. If you have never used Stony Brook's Blackboard system, your initial password is your SOLAR ID# and your username is the same as your Stony Brook (sparky) username, which is generally your first initial and the first 7 letters of your last name. For help or more information see: https://tlt.stonybrook.edu/StudentServices/BbStudents/Pages/default.aspx For problems logging in, go to the helpdesk in the Main Library SINC Site or the Union SINC Site, you can also call: 631-632-9602 or e-mail: helpme@ic.sunysb.edu
Expectations

1. Communication
Outside the class, I use email and blackboard exclusively to communicate with you, therefore please make sure that your email id is a current one on the blackboard system

2. Pre-requisites
This class requires that you must have taken a course in Linear Algebra and Differential Calculus and have some programming experience. For programming assignments, I will provide skeleton code in C++. Although I prefer code in C or C++, you are free to use any environment (Linux/Unix/Windows) and any language (Java, C++, C, Fortran, php) for writing your programs. If you are not familiar with any programming language or have forgotten the syntax, pick up an elementary programming book on your language of choice and brush up on your programming skills quickly. I do not expect you to write very sophisticated or high performance code but it should be readable and easy to understand.

Academic Conduct and Integrity

The campus policies on academic honesty are available on the Web (http://naples.cc.sunysb.edu/CAS/ajc.nsf/pages/info). Academic dishonesty is an extremely serious offense and will not be tolerated in any form. Academic dishonesty in general is the presentation of intellectual work that is not originally yours. Examples include, but are not limited to, copying or plagiarizing class assignments including homework, reports, designs, computer programs, graphics, and other submitted materials; copying or otherwise communicating answers on exams with other students; bringing unapproved aids, either in physical (written) or electronic form to an exam; obtaining copies of an exam prior to its administration, etc. Academic dishonesty violates both the ethical and moral standards of the Engineering profession and all infractions related to academic dishonesty will be prosecuted to the fullest via the CEAS CASA committee. For you, the honest student, academic dishonesty results in lower class curves, hence a depression in your GPA and class standing, while cheapening the degree you earn.

Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at http://www.stonybrook.edu/uaa/academicjudiciary/

Special Note on ADA

If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, ECC (Educational Communications Center) Building, room 128, (631) 632-6748. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential. Students requiring emergency evacuation are encouraged to discuss their needs with their professors and Disability Support Services.