Statement of Teaching

Fuhua (Frank) Cheng

A. Teaching

1. Reflective Statement

My teaching has three goals: (1) to make sure that students understand the course materials well, (2) to make sure that students know how to use/apply the materials they learn in class, and (3) to make sure that the students are evaluated fairly.

To achieve the first goal,

- I use a motivation-driven approach in my lecture, i.e., I give the background and applications of the result first, and then explain the theory that leads to the result.
- I give many examples in my notes (see, e.g., my CS535 and CS633 notes).
- I encourage the students to be involved and active during lectures. (However, for those who find it difficult to do so, I welcome them to ask questions or make comments after class.)
- I make all my class notes available on line so that, instead of copying my notes in class, they can closely follow my lectures on course materials. (My class notes such as CS633, CS631, CS535, and CS321 have been used by some of my students and colleagues in their own classes.)

To achieve the second goal,

- I give applications for each covered result.
- I provide students with sample programs to help them initiate their work (see my web pages).
- I encourage students to share their ideas.
- I award students with extra credit if they have new ideas on assignments.

To achieve the third goal,

- I always let the students know at the outset of the course exactly what is expected. I clearly specify the requirements of the course such as materials to be covered, grading policy, program requirements (see, e.g., my CS535 and CS633 Programming Requirements), late penalty, and numerical scale to be used in the evaluation, on the first day of class.
- I provide students with solution sets for all homework assignments and exams (see my webpages) so they would not only know the solutions to the questions, but also know if their works are graded fairly.

I have different expectations for graduate and undergraduate students though. For an undergraduate or programming-extensive course, the students are evaluated based on two subjects: programming assignments and tests. I usually put equal weight on both sides so the effort of the students can be evaluated fairly. However, I encourage students to do critical thinking and they get extra credit if they do so such as providing comments or improvement on existing techniques. For a seminar course or advanced topics, I evaluate the students mainly based on the quality of the work, i.e., I will follow the numerical scale, but a student with good ideas will get more extra credit than the ones who don’t.

2. **Courses taught recently**

Course	Title	Level
CS633	Computer Animation	G
CS535	Intermediate Computer Graphics	G
CS321	Intro. Numerical Methods	U
CS275	Discrete Mathematics	U

3. **Student Evaluation (recent three semesters)**

		2004		2005		2006
		Spring	Fall	Spring	Fall	Spring
		633	321	275	535	633
	Enrollment	13	26	34	24	9
	Number of answers	8	16	23	17	5
1	Material/grading outlined	3.4	3.6	3.3	3.6	3.8
2	Textbook	3.4	2.7	2.9	3.4	3.6
3	Supplemental reading	3.5	3.6	3.3	3.6	4.0
4	Exams reflection	3.4	3.8	3.6	3.7	4.0
5	Grading fair	3.5	3.6	3.6	3.6	4.0
6	Distributing assignments evenly	3.5	3.4	3.5	3.8	4.0
7	Assignments graded promptly	3.3	3.5	3.7	3.6	4.0
8	Grading including comments	3.4	3.3	2.9	3.5	4.0
9	presentation	3.6	3.7	3.3	3.5	4.0
10	Knowledge of subject	3.6	3.8	3.6	3.8	4.0
11	Availability	3.5	3.9	3.5	3.6	3.8
12	Answer questions	3.4	3.7	3.4	3.5	4.0
13	Stimulate interest	3.1	3.6	2.8	3.5	4.0
14	Encourage participation	3.3	3.4	3.4	3.5	3.8
15	Respect viewpoints	3.6	3.2	3.2	3.5	3.8
16	Ability to analyze	3.3	3.4	3.3	3.5	4.0
17	Solve problems	3.3	3.4	3.2	3.5	4.0
18	Understand concepts	3.4	3.4	3.2	3.8	4.0
19	Read further	2.9	3.2	2.6	3.6	4.0
20	Value of course	3.3	3.8	3.2	3.6	4.0
21	Quality of teaching	3.4	3.9	3.5	3.8	4.0

B. Advising

1. **Reflective Statement**

My goal in advising a project or a thesis is to ensure that the student knows how to set up a target and how to develop a strategy to reach that target. The target must be very specific and the strategy must be practical. The idea is to let the student know how to play a game by him/her-self and to what extent that he/she should keep trying before giving up. I help the student with the technical part initially after he/she has successfully performed background study, target selecting, and strategy design.

My advising in pre-registration meetings with the students will ensure that (1) students understand the requirement of a computer science major in addition to the college and university requirements, and (2) each student develops an appropriate course plan for each semester. This will be achieved by going through a checklist with the student and showing him/her the best combination for the semester.

2. **Students Advised - Post Docs (past three years)**

- **Jianbao Wu**

  Qualification: *PhD, Mathematics, August 2007, University of Georgia*

  (Thesis: *Spherical Splines for Hermite Interpolation and Surface Design)*

  Area of Research: *Subdivision surface based Offsetting*

  Starting Date: November 2007

  Supported Period: November 2007 - present (supported by NSF grant DMI-0422126).

  Publication: None

3. **Students Advised - PhD Students (past three years)**

- **Shuhua Lai**

  Area of Research: *Subdivision surface based one-piece representation*

  Starting Date: January 2003

  Supported Period: January 2003 - May 2006 (supported by NSF grant DMS-0310645).

  Current Status: *Assistant Professor, Virginia State University*

  Publication: six journal papers, seven conference papers

  Graduation Date : September 2006

- **Fengtao Fan**

  Area of Research: *Shape Reconstruction using Subdivision Surfaces*

  Starting Date: August 2006

  Publication: *four conference papers (in preparation).*

  Supported period: August 2006 - present (supported by NSF grant DMI-0422126).

  Anticipated Graduation Date : May 2009.

4. **Students Advised - MS Students (past three years)**

- **Jidong Qu**

  Masters Project: *Shape Modeling using Subdivision Surfaces*

Date of graduation: March 2005.

- **Gang Chen**

  Masters Thesis: *Subdivision Depth Computation for Extra-ordinary Patches*

  Publication: one Journal paper (Subdivision Depth Computation for Subdivision Surfaces)

  Supported period: August 2004 - December 2005 (supported by NSF grants DMS-0310645 and DMI-0422126).

  Date of graduation: December 2005.

- **Conglin Huang**

  Masters Project: *Curvature Estimation for Triangular Meshes based on Local Parametrization*

  Current Status: *theory development stage*

  Supported period: January 2007 - present (supported by KSTC grant 144-401-07-015).

  Date of graduation: May 2008.

- **Jiaxi Wang**

  Masters Project: *Shape Reconstruction using Doo-Sabin Subdivision Surfaces*

  Current Status: *implementation stage*

  Supported period: August 2007 - present (supported by KSTC grant 144-401-07-015).

  Date of graduation: March 2008.

Statement of Research

Fuhua (Frank) Cheng

1. Research Interests

My research interests are in *graphics* and *geometric modeling*, with special emphasis on *computation* techniques for rendering and geometric problems, and *modeling* of geometric shapes.

My work covers *geometric/solid modeling*, *CAD/CAM*, *reverse engineering*, *finite-element mesh generation*, *biomedical imaging*, and *collaborative CAD*.

2. Research Achievements

My major research achievements include:

- **Development of first hardware device for curve generation/rendering**

- "Bezier Curve Generator: A Hardware Approach to Curve Generation" (with K.R. Hsieh, R.R. Huang and Y.H. Chin), Proc. 1985 Int. Symp. VLSI Technology, systems and Applications, Taiwan, 278-281.

  A special hardware, based on *parallel subdivision*, supports fast and numerically stable generation/rendering of parametrically defined curves. This work won me the prestigious *Dr. Sun Yat-Sen Technology Invention Award* in 1985.

- **Development of a new spline scheme**

- "Alternate Spline: A Generalized B-Spline" (with A. P. Bien), J. Approximation Theory 1987, 51(2):138-159.

  Each degree n spline basis function is composed of polynomials of degree $n-1$ and n alternately. A degree n parametric alternate spline curve is composed of curve segments of degree $n-1$ and n alternately and, yet, the curve is C^{n-1} continuous. Therefore, it provides the same kind of smoothness of a degree n B-spline curve but with smaller construction and generation cost.

- **Initiated a new research area: Parallel B-Spline Algorithms**

- "A Parallel B-Spline Surface Fitting Algorithm" (with A. Goshtasby), ACM Trans. on Graphics 1989, 8(1):41-50.

  Publication of the above paper started a research area called *Parallel B-Spline Algorithms*. The area is still active today.

- **Discovering B-Splines are digital filters**

- "B-Spline Curves and Surfaces viewed as Digital Filters" (with A. Goshtasby and B. Barsky), Computer Vision, Graphics, and Image Processing 1990, 52(2):264-275.

  By observing that B-Spline curves and surfaces can be viewed digital filters, it is now possible to use digital filter techniques to solve geometric problems such as curve and surface fitting.

- **Development of a new shape design technique called INTERPROXIMATION**

- "Interproximation: Interpolation and Approximation using Cubic Spline Curves" (with B. Barsky), Computer Aided Design 1991, 23(10):700-706.

- "Interproximation using Cubic B-Spline Curves" (with B. Barsky), Modeling in Computer Graphics: Methods and Applications, ed. B. Falcidieno and T.L. Kunii, Springer-Verlag, Berlin (1993), 359-374.

  A new shape design technique by combining interpolation and approximation into a single process. It allows a user to design a curve using both points and regions, instead of just points.

- **Best result in Parallel B-Spline Algorithms**

- "Parallel B-Spline Surface Interpolation on a Mesh-Connected Processor Array" (with J. Wang, G. Wasilkowski et al), J. Parallel & Distributed Computing 1995, 24, 224-229.

  The best result in Parallel B-Spline Algorithms is achieved by the above paper by showing that constant time performance is possible for surface fitting problem.

- **Most efficient rendering technique for trimmed NURBS surfaces**

- "Rendering Trimmed NURBS Surfaces" (with W.L. Luken), IBM Report RC18669, 1992.

- "Surface and Derivative Evaluation Methods for the Rendering of NURBS Surfaces" (with W.L. Luken), IBM Report RC18670, 1993.

- "Computing Step Sizes for the Tessellation of Trimmed NURBS Surfaces" (with W.L. Luken), IBM Report RC18499, 1993.

- "Comparison of Surface and Derivative Evaluation Methods for the Rendering of NURB Surfaces" (with W.L. Luken), ACM Trans. on Graphics 1996, 15(2):153-178.

  A tessellation-based, rendering technique for trimmed NURBS surfaces. The new technique provides solutions to two major problems in trimmed NURBS surface rendering: *Computational efficiency and numerical stability* and *crack problem*. A version of this algorithm has been implemented in micro code in IBM's Risc machines.

- **Constrained shape scaling techniques**

- "Constrained Shape Scaling of Trimmed NURBS Surfaces using Fix-and-Stretch Approach" (with P. Zhang and C. Zhang), Computer Aided Design 2001, 33(1):103-112.

- "Constrained Shape Scaling of Multi-Surface Objects" (with P. Zhang and C. Zhang), Proc. Geometric Modeling & Processing 2000, Hong Kong, 398-407.

- "Constrained Scaling of Catmull-Clark Subdivision Surfaces" (with S. Lai and S. Zou), Computer-Aided Design & Applications 2004, 1(1-4):7-16.

  A technique to hold significant features of a model unchanged while globally or locally alternating (scaling) it. This technique provides the design industry with the capability of globally or locally modifying an existing model in length, height, or width without affecting certain significant features and, consequently, avoiding expansive redesign

process.

- **Error control for subdivision surfaces**

- "Subdivision Depth Computation for Catmull-Clark Subdivision Surfaces" (with J. Yong), Computer Aided Design & Applications 2006, 3(1-4):485-494.

- "Subdivision Depth Computation for Extra-Ordinary Catmull-Clark Subdivision Surface Patches" (with G. Chen and J. Yong), Lecture Notes in Computer Science Vol. 4035, Springer, 2006, 404-416.

- "Matrix based Subdivision Depth Computation for Extra-Ordinary Catmull-Clark Subdivision Surface Patches" (with G. Chen), Lecture Notes in Computer Science, Vol. 4077, Springer, 545-552.

  With the above results, Catmull-Clark subdivision surfaces can be used for CAD/CAM applications now. This is important because Catmull-Clark subdivision surfaces include B-spline and NURBS surfaces as special cases. Therefore, if one can control the precision of a Catmull-Clark subdivision surface, then a universal representation for all CAD/CAM applications can be developed and a universal language for all CAD/CAM applications can be adopted.

- **Parametrization of Catmull-Clark subdivision surfaces**

- "Parametrization and Computation of Catmull-Clark Subdivision Surfaces" (with S. Lai), Computer Aided Design & Applications 2006, 3(1-4):513-522.

  The above work improves J. Stam's SIGGRAPH paper by giving a representation with only half the basis functions. Besides, all the basis functions are explicitly given, not look-up tables are needed. So, a complete parametrization technique of Catmull-Clark subdivision surfaces is finally available.

My other contributions include:

- *Adaptive Rendering/Tessellation of Subdivision Surfaces* -
- *Texture Mapping for Subdivision Surfaces* -
- *Adaptive Subdivision of Subdivision Surfaces* -
- *Streamline Modeling* -
- *Collaborative CAD* -
- *Label-driven subdivision* -
- *Knot Reduction of NURBS Representation* -
- *Bessel Interpolation* -
- *Rate of Convergence* -
- *Curve/surface fairing* -
- *Shape Reproducing and Shape Preserving Interpolation* -

- *Parametric blending -*
- *Shape generation on irregular mesh -*
- *Surface Connection -*

3. Current Research Projects:

Three research projects are undergoing now. These include

(1) "Tessellation, Fairing, Shape Design, and Trimming Techniques for Subdivision Surface based Modeling", NSF (DMI-0422126), 9/1/04-8/31/08, $300,000.

(2) "Portable Digital Mouth and Occlusion Reproducing", KSTC (144-401-07-015), 4/1/07-3/31/09, $150,000.

(3) "On New Algorithms of Curve and Surface Modeling Based on Probabilistic Type Operators and Probability Distribution" (Co-PI), NSF of China (NSFC-10571145), 01/01/2006-12/31/2008, RMB$280,000 (US$35,000).

4. Future Research Plans:

Future research will focus in the following three areas:

(1) **Non-Invasive Mouth Reproducing** : by working with people in vision and dental area, novel data acquisition device and powerful subdivision surface based reverse engineering techniques will be developed so that a dentist can reproduce a patient's mouth without using the traditional impression-taking approach.

(2) **Mesh Interpolation and Mesh Expansion** : to develop an ultimate solution for mesh interpolation problem and Fourier-transform-like expansion techniques for meshes (surfaces). A mesh expansion contains high frequency and low frequency information of the given mesh and hence can provide us with new or alternative solutions to problems in texture mapping, denoising, and morphing.

(3) **Virtual 3D Plastic Surgery** : to work with people in plastic surgery area to develop a realistic 3D facial plastic surgery simulator. The technologies developed here would make outcome prediction of plastic surgery possible and, consequently, reduce the risk for any given patient.