Yunhe Shen

603 Causley Ave. Apt. 53
Arlington, TX 76010
817-272-5719 (Lab)
817-275-3002 (Home)
yunhe.shen@gmail.com

EDUCATION

Ph.D. in Biomedical Engineering, Joint Program at University of Texas Southwestern Medical Center at Dallas and University of Texas at Arlington, 2000 – 2005
Dissertation: Real time collision detection and soft tissue deformation for haptic simulation of laparoscopic surgery (See abstract attached).
M.S. in Biomedical Engineering, 3-year Program, Zhejiang University, China, 1997 – 2000
Thesis*:* COM/DCOM based remote monitoring system for medical instruments.
B.S. in Biomedical Engineering, 5-year Program, Zhejiang University, China, 1990 – 1995

Core courses:

- **Life Science**: Human Physiology, Human Anatomy and Dissection Lab, Biochemistry, Medical Chemistry, Biostatistics.
- **Biomedical and Electrical Engineering***:* Modeling and Control of Biological Systems, Quantitative Physiology, Bioinstrumentation, DSP, DIP, Analog and Digital Electronic Circuits, Principles of Automatic Control, Principles of Transducer, Biomedical Detecting Technology, Biothermodynamics, Basic Engineering Economics and Management.
- **Computer Science and Engineering***:* Computer Graphics, Computer Vision, Microprocessor System, Operating System, Database System, C language and Data Structure.
- **Mechanical and Materials Engineering***:* Theoretical Mechanics, Material Mechanics, Medical Materials.

AWARDS

Outstanding Ph.D. student award, joint BME program at UTA and UTSW, 2004
Scholarship, University of Texas at Arlington, 2000
Scholarships, Zhejiang University, 1994 & 1990

RESEACH EXPERIENCE

Lead Research Assistant, Virtual Environment Lab, UTA, TX, 2001 - 2005
Advisors: Venkat Devarajan, Robert Eberhart

- ***VR based surgery simulator****:* Developed prototype bimanual haptic simulator for laparoscopic surgery, implemented with VC++, OpenGL, and haptic programming.
  Tasks and achievements: collision detection (applicable to virtual environments, CG, CAD/CAM and robotics), deformable tissue modeling, haptic and visual rendering, visualization, framework design, programming, and technically supervising a research team consisting of 16 master and PhD students.

Research Assistant, Biomedical Optics Lab, UTA, UTSW, TX, 2000 - 2001
Advisor: Hanli Liu

- ***Near-infrared imaging and simulation****:* Employed in vivo experiments and Monte-Carlo simulation to detect and guide catheter path in brain surgery.

Research Assistant, BME Department, Zhejiang University, China, 1997 - 2000
Advisor: Dake Hu
Lead Research Engineer, Boulson Inc., Hangzhou, China. 1995-2000
Supervisor: Pingmian Lu

- ***Image and video processing****:* Developed 4 systems respectively for ultrasonography, micrography, endoscopy and X-ray data recording and processing, implemented with VC++.
- ***Bioinstrumentation****:* Wrote software package for blood cell analyzer (Medonic CA530/620); including data communication, cell classification and quality control, implemented with VC++.
- ***Telemedicine****:* Built multicast LAN for multimedia online demo and live broadcast.

Research Assistant, BME Department, Zhejiang University, China, 1994 -1995
Advisor: Dake Hu

- ***ECG (EKG) DSP****:* Spectral analysis of heart rate variability (HRV); diagnosis package implemented with C++.

TEACHING EXPERIENCE

Teaching Assistant, BME Department, UTA, TX, 2004 - 2005

- TA Courses: Digital Processing of Biological Signals
  Process Control in Biotechnology
- Tasks: Preparing teaching materials, developing class websites, and grading.

Tutor, Virtual Environment Lab, UTA, TX, 2002 - 2005

- Trained new research assistants for surgery simulation project. Organized lectures, seminars, and workshops.

TECHNICAL SKILLS

Programming: Visual C++, OpenGL, VTK, Ghost SDK, Pascal, Fortune.
Toolkits: Matlab, 3D Studio Max, Adobe Photoshop, CorelDRAW, Macromedia Dreamweaver.

PUBLICATIONS

Yunhe Shen, Venkat Devarajan and Robert Eberhart, "*OHC: A spatial tessellation algorithm for real time collision detection,*" submitted to IEEE Trans. Visualization and Computer Graphics.

Yunhe Shen, Venkat Devarajan and Robert Eberhart, "*Haptic herniorrhaphy simulation with robust and fast collision detection algorithm,*" Proc. Medicine Meets Virtual Reality, 2005.

Yunhe Shen, Venkat Devarajan and Robert Eberhart, "*Virtual surgery: a bimanual haptic framework for laparoscopic surgery training,*" ACES 2004, Univ. of Texas at Arlington.

Yunhe Shen, "*Electric-magnetic fields and human health,*" J. Foreign Medical Sciences, Biomedical engineering fascicle, Chinese edition, Vol. 23-1, 2000.

Yunhe Shen, Shijun Lian and Dake Hu, "*Digitization of medical ultrasonic information,*" J. Medicine and Engineering, Chinese edition, Vol.1-1, 1999.

REFERENCES

Professor Venkat Devarajan, Department of Electrical Engineering, UT Arlington
416 Yates Street, Arlington, TX 76010. 817-272-3485, venkat@uta.edu

Professor Robert Eberhart, Department of Surgery, Joint BME Program, UT Southwestern Medical Center
5323 Harry Hines Boulevard, Dallas, Texas 75390. 214-648-2052, robert.eberhart@utsouthwestern.edu

Professor Khosrow Behbehani, Chair, Department of Biomedical Engineering, UT Arlington
501 West First Street, Arlington, TX 76010. 817-272-2055, kb@uta.edu

Professor Mark Watson, Department of Surgery, UT Southwestern Medical Center at Dallas
5323 Harry Hines Boulevard, Dallas, Texas 75390. 214-645-0500, mark.watson@utsouthwestern.edu

Professor Daniel Jones, Chief, Section for Minimally Invasive Surgery, Beth Israel Deaconess Medical Center
330 Brookline Ave, Boston, MA 02215. 617-667-5101, djones1@bidmc.harvard.edu

ABSTRACT

REAL TIME COLLISION DETECTION AND SOFT TISSUE DEFORMATION FOR HAPTIC SIMULATION OF LAPAROSCOPIC SURGERY

by

YUNHE SHEN

This dissertation describes the research, development and implementation of a prototype laparoscopic surgery simulator. Theoretical solutions to the collision detection and deformation problems are developed. These two topics form the major part of this research since they are two of the most challenging problems in virtual reality based medical simulation and other applications that demand intensive simulated interaction.

Specifically, this research addresses collision detection problems in complicated simulation scenarios, in which there are highly deformable objects with varying convex or concave shapes, objects with topological complexity such as bundled, porous or spongy structures, particle systems and polygon soup, changing topology due to cutting or suturing operations and, a large number of moving objects. Real time applications with some of these complexities demands robust, generic and fast solutions. This dissertation presents an algorithm, which uses a spatial occupancy test, and a hashed and cascaded data structure (OHC) to solve real time collision detection problems. This algorithm can be a generic solution for specific collision detection scenarios in various applications. In addition, this dissertation also proposes and implements schemes that optimize the algorithm for certain applications. The OHC algorithm has been validated in several real time virtual environments, including surgery simulation with haptic feedback. The real time performance of this method is analyzed with an emphasis on the correlation between collision detection time and collision ratio.

For deformations at haptic rates an enhancement to the existing mass spring modeling method is derived. In this approach, shape constraint such as volume and area elasticity is studied, and the constraint vectors are determined by a new circumcenter alignment method. The classic mass spring model can be enhanced and simplified with a balloon model employing isotropic and homogeneous assumptions; one which computes global volume or area constraints for elastic objects, replaces the bending or shearing springs, and offers more flexibility in adjusting bending and shearing resistances. Compared with the mass spring model, the balloon model has achieved improved elastic effects in modeling surface objects. This model can also be used to simplify the volumetric mass spring structures or to reduce the computation load.