

Zhongqing Han

SOFTWARE ENGINEER · SIMULATION RESEARCH ENGINEER

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Education

Rensselaer Polytechnic Institute, Center for Modeling, Simulation, and Imaging in Medicine (CeMSIM)

Troy, NY

PH.D. IN MECHANICAL ENGINEERING, SUPERVISED BY PROF. SUVRANU DE. GPA 3.95/4.0

Jul. 2018

- THESIS: Real-time Multi-physics Modeling of Radio-frequency Electrosurgical Procedures

University of Science and Technology of China, Department of Precision Machinery and Precision Instrumentation

China

M.S. IN MECHANICAL ENGINEERING

Jun. 2012

University of Science and Technology of China, Department of Precision Machinery and Precision Instrumentation

China

B.S. IN MECHANICAL ENGINEERING

Jun. 2009

Professional Skills

Research

PHYSICAL SIMULATION, RIGID/SOFT BODY SIMULATION, ROBOTICS SIMULATION, SURGICAL SIMULATION/TRAINING, COLLISION DETECTION, CONTACT RESPONSE, HIGH PERFORMANCE COMPUTING, MACHINE LEARNING

Operating Systems

WINDOWS, LINUX

Programming

C++/C(PROFICIENT), MATLAB(PROFICIENT), PYTHON(PROFICIENT), CUDA(PRIOR EXPERIENCE), OPENGL(PROFICIENT), WebGL(PRIOR EXPERIENCE), QT(INTERMEDIATE), VTK(PROFICIENT), TENSORFLOW(INTERMEDIATE)

Game Engines

UNITY(PRIOR EXPERIENCE), UNREAL(PRIOR EXPERIENCE), PHYSX/FLEX (PRIOR EXPERIENCE)

VR and haptic device

ZSPACE, OCULUS RIFT, HTC VIVE, LEAP MOTION, TOUCH HAPTIC DEVICE

Core Courses

Mathematics

COMPUTATIONAL LINEAR ALGEBRA, NONLINEAR PROGRAMMING

Mechanics

MECHANICS OF SOLIDS, INTRODUCTION TO HAPTICS, FUNDAMENTALS OF FINITE ELEMENT, FINITE ELEMENT PROGRAMMING, MODERN ROBOTICS

Computer Science

ALGORITHMS: DESIGN AND ANALYSIS, PARALLEL COMPUTING, ADVANCED COMPUTER GRAPHICS, MACHINE LEARNING, PHYSICS BASED ANIMATION

Research Projects

Virtual Electrosurgical Skill Trainer (VEST)

Troy, NY & Boston, MA & Carrboro, NC

RESEARCH ASSISTANT AT CEMSIM & RESEARCH COLLABORATOR AT CARL J. SHAPIRO SIMULATION & SKILLS CENTER

& LONG-TERM VISITOR AT KITWARE

- **Summary:** Conducted research and development on a five year NIH-funded project "Virtual Electrosurgical Skill Trainer (VEST)". Built a virtual reality (VR) based trainer (5 modules) with visual and haptic feedback, allowing the trainees to attain competence in a controlled environment. Overcome several technological challenges including (a) Realistic physics-based simulation of the complex bio-physics; (b) Real-time interactive rendering and computing; (c) Novel realistic VR interfaces, graphic user interface and haptic feedback
- **Module 1 (Tissue effects):** Developed GLSL based physically-accurate rendering of various tissue effects in a stereoscopic LCD display (Zspace)
- **Module 2&4 (Current flow):** Developed an immersive and interactive GUI using QT and VTK for volume rendering of current flow within virtual human data set
- **Module 3 (Bipolar cutting):** Developed robust ambidextrous manipulation (robotic grasping) in virtual environment and efficient topological management mechanism
- **Module 5 (OR fire training):** Developed an OR fire virtual training simulator using OpenGL and Unreal Engine and customized 3D models of operating room using 3ds Max

High performance computing for real-time interactive physical simulation

Troy, NY

RESEARCH ASSISTANT AT CEMSIM

- Developed deflation based block preconditioner for solving large scale multi-physics simulation, which resulted in linear increase in computational cost with increase in number of degrees of freedom
- Proposed a CNN-based hybrid approach to accelerate the large scale multiphysics simulation. Improved computational efficiency by 36%
- Proposed a dual mesh algorithm for physics-based cutting simulation, with at least 2.7x speed up
- Developed a GPU-based computationally efficient and thermodynamically consistent level set method to simulate surgical cutting, with maximum speed-up of 10x when compared with CPU

Physically-based simulation for virtual humans & organs

Troy, NY

RESEARCH ASSISTANT AT CEMSIM

- Developed finite element method for elastically deformable models of virtual human tissue & organs
- Developed finite element method for 2D elastic deformable models of cloth-like simulation

Real-time collision detection and contact modeling

Troy, NY

RESEARCH ASSISTANT AT CEMSIM

- Developed high-level bounding volume hierarchies & low-level basic primitive tests
- Developed efficient collision detection algorithm for implicit surfaces
- Developed efficient solvers for linear complementarity problem between rigid bodies
- Developed contact modeling between soft and rigid bodies (mixed linear complementarity problem)

Experience

Professional Experience

- **Visiting Allied Health** for **SAGES** (Society of American Gastrointestinal and Endoscopic Surgeons) 2017 Annual Meeting, Houston, Texas, March 2017
- **Faculty** of Workshop - VEST at the 9th Annual **ACS-AEI** (Division of Education of the American College of Surgeons and the Program for Accreditation of Education Institutes) Postgraduate Course, Carl J. Shapiro Simulation & Skills Center, Beth Israel Deaconess Medical Center, Boston, Massachusetts, September 2016
- **Research Collaborator** at Carl J. Shapiro Simulation & Skills Center, Beth Israel Deaconess Medical Center, Boston, Massachusetts, September 2015 - June 2016
- **Visiting Allied Health** for **SAGES** (Society of American Gastrointestinal and Endoscopic Surgeons) 2016 Annual Meeting, Boston, Massachusetts, March 2016
- **Long-term visitor** at **Kitware**, Developed interactive GUI using VTK in the virtual environment and contributed to the Interactive Medical Simulation Toolkit (IMSTK), which is a free & open source software toolkit written in C++ that aids rapid prototyping of interactive multi-modal surgical simulations, Carrboro North Carolina, May 2016 - Present

Teaching Experience

- Teaching assistant for the undergraduate Vibrations class, Aug. 2014 - Dec. 2014
- Teaching assistant for the undergraduate Introduction to Manufacturing Planning class, Jan. 2013 - May 2013
- Teaching assistant for the undergraduate Introduction to Engineering Analysis class, Aug. 2012 - Dec. 2012

Publications

Journals

- **Z. Han**, Rahul, and S. De, Accelerating multiphysics simulation for electrosurgery with convolutional networks, prepared for *Comput. Methods Appl. Mech. Engrg.*, 2018
- M. Dombek, C. A. López, **Z. Han**, D. B. Jones, J. Olasky, S. Schwaitzberg, C. Cao, S. De, FUSE certification enhances performance on a virtual computer based simulator for dispersive electrode placement, *Surgical Endoscopy*, 2018, pp 1-6
- **Z. Han**, Rahul, and S. De, A multiphysics model for radiofrequency activation of soft hydrated tissues, *Comput. Methods Appl. Mech. Engrg.*, 337(2018), 527-548
- Z. Lu, V. S. Arikatla, **Z. Han**, B. F. Allen, and S. De, A physics-based algorithm for real-time simulation of electrosurgery procedures in minimally invasive surgery, *Int. J. Med. Robot.*, 10(2014), 495-504
- L. Sun, J. Wand, **Z. Han**, and C. Zhu, Active Vibration Suppression Based on Intelligent Control for a Long-range Ultra-precise Positioning System, *Applied Mechanics and Materials*, 87(2011), 123-128

Proceedings

- S. De, **Z. Han** and Rahul, A multi-physics model for radiofrequency ablation of soft tissue, *55th Society of Engineering Science Technical Meeting (SES 2018)*, 2018; Madrid, Spain
- **Z. Han**, Rahul and S. De, An efficient solution approach for multiphysics modeling of electrosurgery, *13rd World Congress on Computational Mechanics (WCCM 2018)*, 2018; NYC, NY
- **Z. Han**, Rahul, C. A. López, and S. De, A fast Krylov subspace-based method for multi-physics modeling of electrosurgical cutting of soft tissue, *VII International Conference on Coupled Problems in Science and Engineering*, Invited Sessions, 2017
- M. Dombek, C. A. López, **Z. Han**, D. B. Jones, J. Olasky, S. Schwaitzberg, C. Cao, S. De, The virtual electrosurgical skill trainer (VEST)-Face validation of a dispersive electrode placement module, Poster presentation at SAGES 2017 Annual Meeting; 2017 Mar. 22-25; Houston, TX.
- M. Dombek, C. A. López, **Z. Han**, D. B. Jones, J. Olasky, S. Schwaitzberg, C. Cao, S. De, The virtual electrosurgical skill trainer (VEST)-Principles of current pathway, Poster presentation at SAGES 2016 Annual Meeting; 2016 Mar. 16-19; Boston, MA.
- **Z. Han**, V. S. Arikatla, and S. De, A local level set-based approach for modeling electrosurgical tissue cutting, *13rd National Congress on Computational Mechanics*, Minisymposia, 2015
- **Z. Han**, V. S. Arikatla, and S. De, GPU-based parallel algorithms for simulation of Electrosurgery procedures in real-time, *13rd National Congress on Computational Mechanics*, Minisymposia, 2015
- X. Chen, S. Yang, and **Z. Han**, etc., Real-time, 3-dimensional scanning imaging system using tunable lens for dynamic process, *Intelligent computation and Bio-Medical Instrumentation (ICBMI)*, International conference on IEEE, 2012