

Zhongqing Han

SOFTWARE ENGINEER · SIMULATION RESEARCH ENGINEER

The George M. Low Center for Industrial Innovation, 110 8th St, Troy, NY 12180

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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

Expected, Jul. 2018

- THESIS: Real-time simulation of 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 MODELING, SURGICAL SIMULATION/TRAINING, MACHINE LEARNING

Operating Systems

WINDOWS, LINUX

Programming

C++/C(PROFICIENT), MATLAB(PROFICIENT), PYTHON(PROFICIENT), CUDA(PRIOR EXPERIENCE), 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, 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

Computer Science

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

Research Projects

Project 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 modeling of the complex bio-physics; (b) Real-time interactive computing; (c) Novel realistic VR interfaces and haptic feedback

Accelerating multi-physics simulation with convolutional networks^(b)

Troy, NY

RESEARCH ASSISTANT AT CEMSIM

Feb. 2018 - present

- Investigating the possibility of using convolutional networks to reduce the computational complexity of large scale multiphysics simulation in electrosurgery
- Performing data-augmentation to the input pressure fields without the need of running exact solvers
- Creating a set of geometry using level set evolution with randomized velocity for generalization performance with topological change

Characterization of mechanics of electrosurgical cutting for liver tissue^(a)

Troy, NY

RESEARCH ASSISTANT AT CEMSIM

Dec. 2017 - present

- Performing ex vivo tissue experiments to determine fracture toughness of liver tissue using an Electrosurgical Robotic Arm system and infrared thermometry
- Developing an inverse optimization model to characterize the mechanics of electrosurgical cutting

Multi-physics Model for Electrosurgical Cutting of Soft Tissue^(a,b)

Troy, NY

RESEARCH ASSISTANT AT CEMSIM

Jul. 2016 - Oct. 2017

- Developed deflation based block preconditioner for solving large scale multi-physics problem that resulted in linear increase in computational cost with increase in number of degrees of freedom
- Proposed cellular level micromechanical model to describe thermo-mechanical response of soft tissue
- Developed computationally efficient and thermodynamically consistent level set method to tissue fracture

Electromagnetic Simulations (Current Pathway) on AustinMan Voxel Model^(a,b,c)

Troy, NY & Boston, MA & Carrboro, NC

RESEARCH ASSISTANT AT CEMSIM & ALLIED HEALTH PROFESSIONAL MEMBER AT CARL J. SHAPIRO SIMULATION &

Sep. 2015 - Jun. 2016

SKILLS CENTER & LONG-TERM VISITOR AT KITWARE

- Developed an immersive and interactive GUI (QT, VTK) in zspace, later transferred to HTC Vive with Leap Motion
- Demonstrated current flow through virtual human based on Maxwell's equations and how dispersive electrode protects the patient
- Designed several clinically relevant abnormal scenarios due to any abnormal associated conditions (excessive body hair, previous scarring, implants)
- Performed pilot study at Carl J. Shapiro Simulation & Skills Center and face validation at SAGES learning center, with consistently high Likert assessment scores.

Development of the Virtual Electrosurgery Skill Trainer (VEST) for Monopolar Electrosurgical Tasks^(b,c)

Troy, NY & Boston, MA

RESEARCH ASSISTANT AT CEMSIM

Jan. 2014 - Jun. 2015

- Developed the monopolar electrosurgery interactions that include cutting, coagulation and fulguration in VEST
- Controlled the power settings and modes of operation by a virtual electrosurgical unit
- Designed a hardware interface to connect laparoscopic surgical tools with touch haptic device using a trocar mechanism

Physics-based Real Time Computational Technology for Electrosurgical Procedures^(a,b,c)

Troy, NY

RESEARCH ASSISTANT AT CEMSIM

Jan. 2013 - Nov. 2013

- Presented a real-time and physically realistic simulation of electrosurgery, by modeling the electrical, thermal and mechanical properties as three iteratively solved finite element models
- Proposed a dynamic triangulation algorithm based on isotherms to provide sub-finite element graphical rendering of vaporized tissue
- Utilized block compressed row storage (BCRS) structure for computationally efficient changes in the tissue topology
- Transitioned the techniques to a virtual laparoscopic adjustable gastric banding (LAGB) surgical simulator

Virtual Basic Laparoscopic Skill Trainer (VBLaST) - Peg Transfer^(a,b,c)

Troy, NY

RESEARCH ASSISTANT AT CEMSIM

Sep. 2012 - Dec. 2012

- Developed robust ambidextrous manipulation in virtual environment with haptic feedback (similar to robotic grasping and manipulation simulation)
- Resolved rigid body dynamics, collision detection/response and positioning

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
- Visiting Allied Health for **SAGES** (Society of American Gastrointestinal and Endoscopic Surgeons) 2016 Annual Meeting, Boston, Massachusetts, March 2016
- Long-term visitor at **Kitware**, Carrboro North Carolina, May 2016 - Present
- **IDEAS** (Innovation, Design and Emerging Alliances in Surgery: Virtual Surgery) workshop, Carl J. Shapiro Simulation & Skills Center, Beth Israel Deaconess Medical Center, Boston, Massachusetts, November 2013

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, accepted by *Comput. Methods Appl. Mech. Engrg.*, 2018
- 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
- **Z. Han**, Rahul and S. De, An efficient solution approach for multiphysics modeling of electrosurgery, *13rd World Congress on Computational Congress (WCCM 2018)*, 2018
- **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 precess, *Intelligent computation and Bio-Medical Instrumentation (ICBBI)*, International conference on IEEE, 2012