Heng Zhang

Correspondence Address: 34 Hospital Road, Sai Ying Pun, Hong Kong
Personal Website: About - Heng Zhang
Email: mediosrity@gmail.com
Github: MediosZ

Educational Background

Southeast University, School of Instrument Science and Engineering, Master 2020.9 - 2023.7

Southeast University, School of Instrument Science and Engineering, Bachelor of Engineering, GPA(3.56/4.0) 2016.9 - 2020.7

Working Experience

The University of Hong Kong, Faculty of Dentistry, Research Assistant 2023.8 - Present

- Designing 3D printed clear aligners for patients requires significant effort from the doctor. This project aims to investigate an automated approach to creating efficient aligners. My responsibilities include designing the workflow, implementing the necessary components, and validating the effectiveness of the aligners.

Artificial Intelligence Research Innovation Academy, Internship 2019.10 - 2020.1

- The NIST Face Recognition Contest focuses on evaluating the performance of automated face recognition technologies across various civil, law enforcement, and homeland security applications. My responsibilities include collecting and processing facial data, converting the existing Python code to C++, and completing the submission program in accordance with the organizer's specifications.

Publications

1. **H. Zhang**, L. Zhu, J. Shen and A. Song, **"Implicit Neural Field Guidance for Teleoperated Robot-assisted Surgery,"** IEEE International Conference on Robotics and Automation (**ICRA**), London, United Kingdom, 2023, doi: 10.1109/ICRA48891.2023.10160475.

   Motivation: The safety of teleoperated surgery is hardly guaranteed, due to the imperfect input commands limited by remote perception and the coarse modeling of the real environment. Implicit neural field not only can model the environment more accurately, but also it provides additional, useful information.

   Approach: We propose a new framework to avoid the collision of surgery robots and human tissue caused by inaccurate inputs. We directly take the medical volume data and propose to use the implicit neural field to guide teleoperated robot-assisted surgery. The implicit neural field accurately model the surgery environment by learning a signed distance field. Since the implicit neural field is fully differentiable, the gradient at any position can be obtained efficiently, which is mandatory during the optimization of the trajectories. With guidance, the trajectory of the robot manipulator is optimized to work inside a narrow workspace safely.

2. **H. Zhang**, L. Zhu, Y. Xiang, J. Zheng and A. Song, **"Haptic Rendering of Neural Radiance Fields,"** The ACM Symposium on User Interface Software and Technology (**UIST**), San Francisco, California USA, 2023.

   Motivation: While NeRF has demonstrated the ability to generate visually realistic results and has found applications in various fields, its current limitations prevent users from interacting with the generated scenes. This lack of interaction hinders the potential for further applications and advancements of NeRF.

   Approach: We study the haptic interaction with NeRF models to enable the experience of touching objects reconstructed by NeRF. Existing haptic rendering algorithms do not work well for NeRF-represented models because NeRF is often noisy. We propose a stochastic haptic rendering method to deal with the collision response between the haptic proxy and NeRF. Also we propose to compute the gradient stochastically, since the gradients directly obtained from NeRF are unreliable.

3. **H. Zhang**, L. Zhu, Q. Chen, A. Song and L. -F. Yu, **"Augmenting Conversations With Comic-Style Word Balloons,"** in IEEE Transactions on Human-Machine Systems (**THMS**), vol. 53, no. 2, pp. 367-377, April 2023, doi: 10.1109/THMS.2022.3224767.

   Motivation: Comics are a popular and appealing medium to present an imaginary world. It is promising to develop a novel tool to assist conversation by improving the quality and efficiency of interpersonal communication on-site or remotely.

   Approach: We propose a novel approach for enabling comic-style conversation in mixed reality to assist face-to-face conversation. Our approach brings word balloons of comic-style conversation to the real world using the paradigm of transfer learning. The word balloons can adapt to mixed reality scenes, such as the 3D head motion of the speaker, the comic styles, and the speech. During the conversation, our approach updates the word balloons guided by a field learned from comics.

4. L. Zhu, X. Jiang, J. Shen, **H. Zhang**, Y. Mo and A. Song, **"TapeTouch: A Handheld Shape-changing Device for Haptic Display of Soft Objects,"** in IEEE Transactions on Visualization and Computer Graphics (**TVCG**), vol. 28, no. 11, pp. 3928-3938, Nov. 2022, doi: 10.1109/TVCG.2022.3203087.

   Motivation: Haptic feedback is widely used to enhance realism in virtual reality (VR). Shape and softness are two common factors perceived by the users in the haptic rendering of soft objects.

Approach: TapeTouch, a new handheld shape-changing device, provides various shapes and softness in real time. TapeTouch is based on a controllable shape-changing tape, which is mainly composed of four motors and a section of brass tape. The control signals are decoded by a neural network and sent to the motor.

5. **H. Zhang**, L. Zhu, **"Differentiable Collaborative Patches for Neural Scene Representations"** in IEEE Transactions on Emerging Topics in Computational Intelligence (**TETCI**) (Under review)

   Motivation: Neural representations have emerged to be an attractive tool for representing images. Local structures such as uniformly-distributed grids or quad-trees have been introduced to improve neural representations for recovering fine features.

   Approach: We present a new layout solution for the adaptive patches, exploring the potential of the implicit neural field. By allowing the local patches to move freely and scale in the scene, we design a differentiable framework to iteratively compute for the neural representation and update the layout of the local patches. By considering the workload's coverage, overlap, and balance, the patches work collaboratively to cover the scene. We also support overlapping patches, alleviating the discontinuous artifacts of the reconstructed image across the patches.

Projects

Robocup Competition, Humanoid League, KidSize 2018.6 - 2019.10

Introduction: In the RoboCup Humanoid League, autonomous robots with a human-like body plan and human-like senses play soccer against each other, involving dynamic walking, kicking the ball while maintaining balance, visual perception of the ball, other players, and the field, and self-localization.
Responsibility: In the team, I am responsible for the perception of the robot, including identifying the elements of the playground, tracking the ball, and locating other robots. Both machine leanring methods and deep learning approaches are utilized to achieve these goals.

Personal Statement

A passionate researcher with over three years of experience working both independently and within teams, I have a strong interest in Computer Vision, Computer Graphics, Implicit Neural Representations, and their practical applications.
As a proficient programmer with a zeal for coding, I possess vast experience in multiple programming languages. My strong coding skills have contributed to the successful completion of numerous research and engineering projects. Additionally, I have rich experience with Motion Capture System, VR/AR glasses, robotic arms, and haptic devices.
Programming languages: Python, C++, CUDA, Rust. **OS:** Linux, macOS. **Softwares:** LaTeX, Emacs, Blender.

Teaching Experiences

Teaching Assistant for "Computer-Aided Design ", Southeast university Fall 2021
Teaching Assistant for "Computer-Aided Design ", Southeast university Fall 2020

Additional Experiences

Google Summer of Code, 2022, Open Source Development 2022.5 - 2022.11
Open Source Promotion Plan, 2021, Open Source Development 2021.6 - 2021.9
Deecamp, 2019, Deep Learning Summer Camp 2019.6 - 2019.8

References

Lifeng Zhu
Associate Professor
School of Instrument Science and Engineering
Southeast University
China
lifengzhu@seu.edu.cn

Congyi Zhang
Research Fellow
Department of Computer Science
The University of British Columbia
Canada
zhcongyi@gmail.com

Lap-Fai (Craig) Yu
Associate Professor
Department of Computer Science
George Mason University
USA
craigyu@gmu.edu