KEYAN ZHAI

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RESEARCH INTEREST

I am interested in the **perception, modeling, and understanding of the 3D world**. I am particularly excited about topics such as **3D/4D reconstruction**, **neural scene representation**, **neural rendering**, **human pose estimation**, etc. My ultimate aim is to digitize the physical world and explore its applications in industries such as AR/VR, autonomous driving and robotics.

EDUCATION

University of Pennsylvania — *Sep 2021 - May 2023*
*M.S.E. in **Robotics**, Specialization in **Computer Vision**, **GPA: 3.81/4*** — *Philadelphia, Pennsylvania*

ShanghaiTech University — *Sep 2017 - Jul 2021*
*B. Eng. in **Computer Science and Technology**, Merit Student (2019)* — *Shanghai, China*

RESEARCH EXPERIENCE

GRASP Lab, University of Pennsylvania — *Sep 2023 - Present*
Research Assistant, Advisor: Prof. Jianbo Shi — *Philadelphia, Pennsylvania*

- Performed **sparse-view** (as few as 4) **3D reconstruction** of human body and hand with **NeuS2** on the **Ego4D** dataset, including both **static** and **dynamic** scenes; utilized **SAM** for foreground mask segmentation to help volume carving; working on extracting SAM features and utilizing curvature to facilitate 3D reconstruction [**Demo**]
- Created synthetic datasets with **Blender** for sparse-view 3d reconstruction and verified the idea of reconstructing and gluing back trimmed convex pieces outperforms reconstructing the whole concave object [**Demo**]
- Working on extending pooling attention module from POTTER over time and multiple views for **hand pose estimation**

Living Machines Laboratory, ShanghaiTech University — *Jul 2020 - Jan 2021*
Undergraduate Researcher, Advisor: Prof. Andre Rosendo — *Shanghai, China*

- Built a **lightweight** four-legged robot (**2.1 kg**) with 3 DoFs per leg actuated by servo motors using **Solidworks** and **3D printing**; equipped the robot with **IMU** and **strain gauge** sensors for gait balance evaluation [**Demo**]
- Combined **Bayesian Optimization** with Scaffolded Learning for parametric search of the robot's gait controller; proposed a gradually reduced support setting to learn a more stable gait, balancing both speed and safety
- Presented publication [**Slides**] as the **first author** at 16th International Conference on Intelligent Autonomous Systems

RESEARCH PUBLICATION

Zhai, K., Li, C., Rosendo, A. (2022). Scaffolded Learning of In-place Trotting Gait for a Quadruped Robot with Bayesian Optimization. In: Ang Jr, M.H., Asama, H., Lin, W., Foong, S. (eds) Intelligent Autonomous Systems 16. IAS 2021. Lecture Notes in Networks and Systems, vol 412. Springer, Cham. [**Springer**][**arXiv**]

WORK EXPERIENCE

Apple Inc. - Technology Development Group — *May 2022 - Aug 2022*
CVML Intern - AR/VR Algorithm Infrastructure — *Sunnyvale, California*

- Contributed to a large-scale library codebase (**2m+** lines) including **computer vision**, **computer graphics**, and **deep learning** algorithms used for **Apple Vision Pro** with **C**, **C++**, and **CMake**
- Optimized multiple **applications** and **unit tests** for **App Clip Codes** [**Link**], achieving a **60%** speed improvement and removal of dependency on testing resource files, saving **100%** disk space
- Created and automated a comprehensive **test pipeline** for App Clip Codes, encompassing multiple phases including **image rendering** and **processing**, resulting in a **50%** reduction in manual testing steps
- Strengthened the **video processing application** by enabling visualization and restructuring the **concurrent dataflow** of multi-track video replay pipeline, facilitating issue identification for future debugging and feature development
- Streamlined the software development cycle by refactoring library **API**s to a **production-level** with uniformed standards, ensuring best code practices and enabling efficient validation of code quality by the Quality Assurance team

Vijay Kumar Lab - GRASP Lab, University of Pennsylvania — *Jan 2022 - May 2022*
Simulation Developer — *Philadelphia, Pennsylvania*

- Configured **full-stack** simulations of **large-scale** multi-robot systems with more than 60 robots using **Unity** and **ROS**; developed simulation software infrastructures in **Python** and **C++/CMake** with multiple **Docker** containers
- Streamlined the development workflow of cutting-edge **robotic control and planning algorithms** by restructuring them to a common interface, facilitating simplified use of the simulator for researchers across various universities

Shanghai Center for Brain Science and Brain-Inspired Technology *Jul 2019 - Apr 2020*
Software Engineer Intern - Cognitive AI Group *Shanghai, China*

- Developed an online IQ test **web application** [Link] that supports IQ test for both human and machine with **Python**, **Django** and **SQLite** for the first Machine Automated IQ Test Challenge (MAIQ) at **IJCAI-2020** [Link]
- Curated test **dataset** with **700+** IQ test problems including verbal comprehension, diagram reasoning and sequence reasoning; automated **dynamic generation of image dataset** with hierarchical representation of test images

TEACHING EXPERIENCE

AI Summer Camp, UPenn GRASP Lab & Beacon Education | *Teaching Assistant* *Aug 2021 - Aug 2021*

Computer Architecture II (CS211), ShanghaiTech University | *Teaching Assistant* *Sep 2020 - Jan 2021*

ENTREPRENEURIAL EXPERIENCE

Automated Elderly Fall Risk Assessment with 3D Pose Estimation [Code] [Demo] *Jan 2023 - May 2023*
Co-founder / Software Engineer *Philadelphia, Pennsylvania*

- Developed an application based on 3D Human Pose Estimation to automatically test the risk of falling for the elderly; improved joint positional accuracy and robustness with **optical flow** and **sensor fusion** using UKF with IMU data
- Participated in the NSF I-Corps Program to interview 20 experts and customers for customer discovery research

Blitzat/Wizeats - Online Food Ordering [Link] **and AI Dining Assistant** [Link] *Sep 2022 - Mar 2023*
Co-founder / Software Engineer *Philadelphia, Pennsylvania*

- Developed Blitzat, an online food ordering platform using **PHP/Laravel/MySQL** and implemented automatic menu upload with **RESTful API** and **Python**; served **10+** local food businesses with **400+** menu items and **500+** customers
- Designed and prototyped an innovative AI-powered dining assistant app [Demo] with **JavaScript** utilizing OpenAI's GPT/DALL-E API to generate customized recipes including detailed ingredients and cooking steps with images

PROJECTS

Mini Minecraft [Demo] **Computer Graphics (C++/OpenGL/Qt)**

- Created an **interactive 3D** world exploration and alteration Minecraft-style program including a **controllable Player** class with **simple physics** that includes player control, velocity, acceleration, position change, and collision checking
- Implemented **procedural generation** of terrain and cave systems using **noise functions** such as **Perlin** and **FBM**, enabling efficient terrain rendering, chunking and distance-based loading with **multi-threading** techniques
- Expanded upon the existing **lambert shader** to allow for **UV texture mapping** with provided textures

Micro Maya Mesh Editor **Computer Graphics (C++/OpenGL/Qt)**

- Developed a mesh editor application in **C++** including the half-edge mesh data structure and visualization with **OpenGL** that supports Catmull-Clark subdivision, loading and rendering OBJ files, and binding meshes to skeletons

Perceiving Music Quality with various ML models [Code] **Machine Learning (PyTorch/AWS)**

- Created a new training **dataset** of **1950** music segments and applied different types of audio degradation on them; trained **supervised learning models** (**SVM** and **CNN**) on the created dataset to predict the audio quality and evaluated the performance **quantitatively** compared with existing methods

Point-Cloud Based Stair Climbing of MIT Mini Cheetah [Code] **Robotics (C++/PCL/OpenCV)**

- Collected 3d **point cloud** data of stairs using **LiDAR** and built traversability map models; modified the **gait control algorithms** based on the map models to improve the performance of stair climbing for MIT Mini Cheetah

Autonomous Elevator Robot [Demo] **Robotics (C++/ROS)**

- Enabled a mobile robot with a manipulator to take elevators autonomously by detecting and pressing buttons; applied **AMCL** for localization, **OCR-RCNN** for button detection, and **MoveIt!** for motion planning of the manipulator

TECHNICAL SKILLS

Languages	Python, C, C++, CUDA, Matlab, SQL, Assembly, HTML/CSS, JavaScript, PHP
Frameworks	NumPy, PyTorch, Pandas, scikit-learn, Matplotlib, OpenCV, OpenGL, Qt, Django, Flask
Tools	Git, Linux, Shell, CMake, GDB, Valgrind, Docker, AWS, ROS, GoogleTest, Jenkins, Blender