CHENFEI ZHU

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EDUCATION

Columbia University (CU) *New York, USA*

Master of Science in Mechanical Engineering, Concentrated in Robotics & Control, GPA: 3.85/4.00 Expected Dec 2022

- Coursework: Machine Learning, Reinforcement Learning, Computer Vision, Robot Learning, etc.

Wuhan University of Technology (WUT) *Wuhan, CN*

Bachelor of Engineering in Automotive Engineering, GPA: 3.9/5.0 Sep 2016 - Jun 2020

PUBLICATIONS

Boce Hu, **Chenfei Zhu**, Xupeng Ai, and Sunil K. Agrawal, "ACRNet: Attention Cube Regression Network for Multi-view Real-time 3D Human Pose Estimation in Telemedicine", arXiv, 2022. Accessed 11 Oct 2022. Preprint.

- Collected a multi-view upper body movement dataset (UBM) for rehabilitation use, consisting of depth images collected from 16 healthy subjects based on the TruST system.
- Designed a novel end-to-end Attention Cube Regression Network (ACRNet) for multi-view real-time 3D human pose estimation based on depth images and validated the superiority of ACRNet on the ITOP dataset and UBM dataset compared with other state-of-the-art methods.
- Proposed a dynamic fusion module based on a cross-attention mechanism.
- Developed a new deep-learning-based real-time controller for TruST to generate a dynamic motion boundary, replacing the fixed boundary in the sitting task.

Xupeng Ai, Victor Santamaria, Jiawei Chen, Boce Hu, **Chenfei Zhu**, Sunil Agrawal. "A Deep-Learning Based Real-Time Prediction of Seated Postural Limits and its Application in Trunk Rehabilitation." TechRxiv, 2022. Accessed 25 Aug 2022. Preprint.

- Proposed a dynamic boundary configuration for boundary-based assist-as-needed (AAN) upper trunk rehabilitation. Introduced deep learning into boundary-based assist-as-needed controller (BAANC) design.
- Collected human trunk movement data with VICON. Compiled the largest 3D trunk movement dataset in the literature.
- Designed a unique loss function for seated postural limits prediction problems. Did an exploratory study to find the most suitable deep learning model. Compared the performance of different deep learning structures and came up with a combined model that achieved accurate real-time prediction for dynamic boundary design.

RESEARCH AND PROJECTS

SARN: Shifted Attention Regression Network for 3D Hand Pose Estimation in Medical Application, *ROAR Lab, CU*

Research, manuscript under polishment Feb 2022 – Present

- Proposed a novel network architecture, shifted attention regression network (SARN), which is characterized by shifted attention heatmap and soft input aggregation, to perform accurate, robust, and unbiased 3D hand pose estimation (HPE) for medical applications.
- Built a hand movement dataset (PAKH) based on Parkinson's finger tapping test (FTT) by conducting experiments on 17 subjects. PAKH contains 26k depth images collected by a Intel RealSense D435i depth camera with 2 hand joint annotations.
- Proposed method outperforms or achieves state-of-the-art performance on three public datasets: NYU, ICVL, and MSRA datasets, and achieves low error on predicting joint position and all task-specific metrics on PAKH, which indicates that the proposed method can perform accurate and robust HPE and has the potential for medical applications.

Neural Network Hyperparameters Tuning: Reinforcement Learning Approach, *CU* *New York, USA*

Course Project Sep 2021 - Jan 2022

- Collected a dataset of about 18k RGB images of subjects performing Parkinson's finger tapping test; each image contains a human hand with four hand joint annotations, built a simple CNN network for hand joint tracking.
- Proposed a model-based reinforcement learning method for efficient hyperparameter optimization: Designed a reinforcement learning environment to provide observation, action, and reward based on the network's hyperparameters and performance and built a DQN agent to learn how to improve the structure of the network.
- The agent learned how to optimize the hyperparameters of the network from a bad setting within a short time period and achieve human-level accuracy.

Boxing Robot: Design and Motion Tracking, *CU* *New York, USA*

Course Project Oct 2021 – Dec 2021

- Designed and assembled a kind of humanoid robot consisting of two arms and a trunk with 9 degrees of freedom, built a simulator using MATLAB robotics toolbox to simulate the dynamic motion of the robot designed.
- Recorded a boxing motion from two views using two optical cameras and synchronized them by analyzing audio signals, extracted the 3D motion data of 8 upper body landmarks from the synchronized videos using MediaPipe Pose and designed a post-processing algorithm to integrate the motion data predicted from two videos and project it to the workspace of the robot.
- Solved inverse kinematics to get the joint angle in each frame and designed a PID controller to follow the motion trajectory.
- Proposed robot succeeded in mimicking human boxing motion by achieving a mae within 6 degrees for most joints during the following task.

Structural Design and Kinematic Trajectory Analysis of Wheeled Legged Robot, *WUT* *Wuhan, CN*

Undergraduate Graduation Thesis Jan 2020 - June 2020

- Proposed a novel quadruped wheeled-foot separated mobile robot based on a special active suspension with adjustable height by analyzing quadruped bionics.
- Designed and modeled the robot's overall structure, wheel, foot assembly, steering system, and power and control system.
- Calculated the key parameters of the power and control system; selected and arranged electronic components such as robot joint motor, hub motor, and battery on the robot designed.
- Implemented Finite Element Analysis and Motion Analysis on the robot in simulation to verify the reliability of the structure designed.

In-arm Torsion Electromagnetic Active Suspension Project, *WUT* *Wuhan, CN*

Science and Technology Innovation Project Mar 2018 - Mar 2019

- Proposed a novel active suspension with adjustable height, utilized SolidWorks to build the 3D model, which consists of above 100 parts; improved the model through structure optimization and finite element analysis.
- Designed a control system including a controller, motors, valves, etc.; coded in C to achieve adjustable damping and adjustment of body height from 350mm to 650mm.
- The proposed suspension has an adjustable height and a cushioned energy reduction capability, making it suitable for complex terrain.

PROFESSIONAL EXPERIENCE

ROAR Lab, Columbia University *New York, USA*

Research Assistant Sep 2021 – Present

- Led a research project to implement 3D hand pose estimation for medical use; participated in several other projects regarding computer vision, deep learning, and muscle synergy.

Shenzhen Keweitai Enterprise Dev. Co., Ltd. *Shenzhen, CN*

Structural Design Intern Jul 2020 - Sep 2020

- Designed a transmission system in a drone hangar project: used SolidWorks to build the 3D model of the transmission system to lift and position a drone, open the hatch, and transmit power to the manipulator.

Beijing New Energy Automobile Co., Ltd. *Beijing, CN*

Product Planning Intern Jul 2019 - Aug 2019

- Managed and updated a database with thousands of user interview data and optimized the scenario demand database for analyzing the pros and cons of existing products to support the planning of future ones.

PATENTS

- Lin Xu, Chengleng Han, Enkang Cui, Yaohui Zhong, Jiajun Wu, Rui Tang, Yingjie He, **Chenfei Zhu**, Jiaming Cui (2019). **Arm type torsional driving suspension frame**. CN109591533, issued.
- Lin Xu, Chengleng Han, Enkang Cui, Yaohui Zhong, Yingjie He, **Chenfei Zhu**, Jiajun Wu, Jiaming Cui, Rui Tang (2019). **Integrated trailing arm type independent suspension system**. CN109532363, issued.
- Lin Xu, Enkang Cui, Chengleng Han, Yaohui Zhong, Rui Tang, Yingjie He, Jiaming Cui, **Chenfei Zhu**, Jiajun Wu (2019). **A suspension system for realizing height adjustment of a vehicle body**. CN109203896, issued.

SKILLS

- AI: Computer Vision (OpenCV), Deep Learning (PyTorch/ TensorFlow), Reinforcement Learning (Gym/ Stable Baselines)
- Programming: Python, C++, MATLAB, Git, Linux
- Hardware: Mechanical design, SolidWorks, AutoCAD, Mechatronics