

Chang Shi

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EDUCATION

The University of Texas at Austin

Ph.D. of Mechanical Engineering (Advisor: Prof. Ann Majewicz Fey)

Research Interest: Reinforcement Learning; Multi-agent Systems; Robotics; Statistical Machine Learning

Selected Coursework: Reinforcement Learning: Theory/Practice; Robot Learning; Numerical Optimization: Graphics/AI; Time Series Analysis

Austin, TX

Starting Aug 2021

Carnegie Mellon University

Master of Robotics System Development (Advisor: Prof. John Galeotti and Prof. Howie Choset)

Selected Coursework: Deep Reinforcement Learning and Control; Robot Autonomy; Robot mobility; Multimodal Machine Learning; Simultaneous Localization and Mapping; Probabilistic Graphical Models; Computer Vision; Medical Image Analysis; Manipulation, Estimation and Control

Pittsburgh, PA

May 2021

Renmin University of China

Bachelor of Engineering in Computer Science (Advisor: Prof. Xinqi Gong)

Selected Coursework: Algorithm Design and Analysis; Data Structure; Computer Graphics; Computer Vision; Game Theory

Beijing, China

June 2019

PUBLICATIONS

Chang Shi, Ann Majewicz Fey. Haptic Guidance using a Transformer-Based Surgeon-Side Trajectory Prediction Algorithm for Robot-Assisted Surgical Training. Submitted to International Conference on Robotics and Automation (ICRA 2023).

Chang Shi, Zheng Yi, Ann Majewicz Fey. Recognition and Prediction of Surgical Gestures and Trajectories Using Transformer Models in Robot-Assisted Surgery. International Conference on Intelligent Robots and Systems (IROS 2022).

Chang Shi, Dustin P DeMeo, Emma L. Larson, John M. Galeotti, Bryan T. Carroll. Non-rigid cutaneous tissue deformation estimation with iterative RANSAC and TPS from digital images over semi-ambiguous artificial markings. Computer Assisted Radiology and Surgery (CARS 2021).

Yiling Qiao, Chang Shi, Chenjian Wang, Hao Li, Matt Haberland, Xiyang Luo, Andrew M. Stuart, Andrea L. Bertozzi. Uncertainty quantification for semi-supervised multi-class classification in image processing and ego-motion analysis of body-worn videos. Electronic Imaging (EI 2019).

ACADEMIC EXPERIENCE

Human-Enabled Robotic Technology Lab, UT Austin

Research Assistant (Advisor: Prof. Ann Majewicz Fey)

Austin, TX

Aug 2021 - present

- Implemented trajectory prediction for da Vinci robot manipulators during surgical task operation based on time-series modeling and transformer models, trained on the JHU-ISI Gesture and Skill Assessment Working Set (JIGSAWS)
- Designed haptic guidance for surgical tasks and carried out preliminary human subject study on guidance training effect

Biomedical Image Guidance Lab, CMU

Research Assistant (Advisor: Prof. John Galeotti)

Pittsburgh, PA

May 2020 - present

- Tuned customized calibration on Realsense D430 to get point cloud data for dermatological tissue samples 15cm away from the camera
- Operated iterative optimization of bidirectional blob matching and thin plate spline warping for 2D non-rigid registration on images of tissue with artificial pigment markers
- Fusing 2D non-rigid registration with 3D point cloud to construct a deformation model of tissue before and after slicing and cryostat freezing

Biorobotics Lab, CMU

MRSD project leader (Advisor: Prof. Howie Choset)

Pittsburgh, PA

Sept 2019 - Present

- Designed a stiffness-based automatic tumor localization system for minimally invasive surgery on da Vinci Surgical System
- Used PCA and FFT for liver motion estimation, processed point cloud from depth camera and laser sensor to get organ surface information
- Developed customized dVRK robot control code with limited workspace and wrist constraints
- Merged motion compensation with robot control to avoid collisions during robot surgery
- Designed an intelligent palpation planner based on history stiffness feedbacks, successfully achieved 100% recall on tumor identification and only 1.69% of healthy tissue misclassification within 5min 27s

James Carter PIC Lab, UCLA

Research Assistant (Advisor: Prof. Andrea Bertozzi) | CSST Research Program

Los Angeles, CA

June 2018 - Sept 2018

- Optimized feature extraction and change point detection based on video motion on LAPD body-worn camera videos
- Introduced Uncertainty Quantification for graph-based semi-supervised multi-class classification problems, designed a human-in-the-loop system to improve classification accuracy

Mathematical Intelligence Application Lab, Renmin University

Research Assistant (Advisor: Prof. Xinqi Gong)

Beijing, China

Feb 2017 - Dec 2017

- Applied cluster analysis and neural networks to hot spot prediction of multimeric protein binding site

INDUSTRIAL EXPERIENCE

NEC Laboratories America

Research Intern

Princeton, New Jersey

May 2021 - Aug 2021

- Operated object detection and key frame detection using DETection TRansformer (DETR) model on CoLLision Events for Video REpresentation and Reasoning (CLEVRER) dataset
- Designed a transformer style model for inter-object relational reasoning and video question answering on collision events

ENB CTO Innovation Labs, Cisco

Research Intern

San Jose, CA

Sept 2018 - July 2019

- Implemented an ios phone SDK to get phone IMU sensor data and location estimation from Access Point(AP) signals while ensuring user information security based on access control
- Developed novel fusion algorithms to combine AP data with phone IMU data to do path-matching for Connected Mobile Experiences (CMX) Indoor Location, improved indoor localization accuracy
- Set up hardware chips, simulation environment and light-weighted real-time data pipelines to get TB magnitudes of data on physical layer of wireless data transmission
- Designed a deep learning model deepPHY, to surpass Bit and Package Error Rate(BER & PER) of 802.11ax PHY baseline from traditional channel estimation methods, especially on low SNR cases

PROJECTS

Deep Graph Network (DGN) for Multi-agent Cooperation on StarCraft II 25 vs 25 Battle Game

UT Austin | Spring 2022

- Formulated the problem as a Decentralized Partially Observable Markov Decision Process (Dec-POMDP) and compared the performance of DGN and Deep Q Network in StarCraft II game setting
- Did Ablation study on DGN with epsilon-greedy action selection and preference-based action selection

Collaborative Robot Manipulation over Two-arm Handover Problem in Robosuite Simulation

UT Austin | Fall 2021

- Approached the multi-robot collaboration problem through imitation learning and reinforcement learning perspectives
- Compared the performance of Behavior Cloning (BC), Hierarchical Behavior Cloning (HBC), Implicit Reinforcement without Interaction at Scale (IRIS) and Batch Constrained Deep Q-learning(BCQ) on two-arm object handover problem
- Formulated the problem as a Centralized Training Decentralized Execution (CTDE) reinforcement learning paradigm. Tested Independent Soft Actor-Critic (ISAC) and Multi-Agent Deep Deterministic Policy Gradient (MADDPG) algorithms

May I See Your Face? Automatic Face Mask Removal using Generative Adversarial Networks

Carnegie Mellon | Spring 2021

- Tested CycleGAN, Pixel2Pixel and several versions of StyleGAN2 on Flickr-Face-HQ (FFHQ) and MaskedFace-Net dataset. Used Poisson blending for further image generation improvement.

Multimodal Graph-structured Trajectory Prediction with Spatio-temporal Attention Mechanism

Carnegie Mellon | Fall 2020

- Explored Trajectron++ model on NuScenes autonomous vehicle trajectory prediction task, proposed improvements by fusing Lidar data, LaneGCN and Spatial-temporal attention Mechanism

Autonomous Bin Picking in RLBench Simulation

Carnegie Mellon | Spring 2020

- Implemented a state-machine for both forward and resetting process of moving objects between containers for bin picking.
- Used Grasp Quality Convolutional Neural Networks (GQCNN) for optimal grasping pose prediction, and Rapidly-exploring Random Tree (RRT) for trajectory planning.

Arduino Car Based Auto Tracking & Guidance System for The Blind

Renmin University | Fall 2017

- Build a small Arduino car with functionality of voice control, obstacle avoidance and path tracking using real-time video processing, voice recognition and stereo system

TEACHING

- 10-708: Probabilistic Graphical Models. Teaching Assistant, Carnegie Mellon, Fall 2020.
- 10-716: Advanced Machine Learning: Theory and Methods. Teaching Assistant, Carnegie Mellon, Spring 2021.

SKILLS

- **Programming Languages:** Proficient - Python, C/C++, MATLAB; Intermediate - Javascript; Basic - Shell, Scala
- **Frameworks& Libraries:** Proficient - PyTorch, Keras, OpenCV, ROS; Intermediate - TensorFlow, Scikit-Learn
- **Others& Tools:** Docker, Git, Scrapy, Django, Arduino, Raspberry Pi

AWARDS

- Meritorious Winner of the American Mathematical Contest in Modeling, COMAP 2017
- 1st Prize in National Mathematical Modeling Contest, China Capital Areas 2017
- Scholarship of Academic Excellence, Renmin University 2016, 2017 & 2018