

Zhen Zeng

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Research Interests

robot perception for manipulation, semantic mapping, robot programming by demonstration, machine learning

Education

- 2012–2020 **Ph.D. of Electrical and Computer Engineering**
University of Michigan, Ann Arbor, USA, *GPA – 3.90/4.00*
Laboratory for PROGRESS, The Intelligent Robotics Lab
Mentors: Prof. Odest Chadwicke Jenkins & Prof. Benjamin Kuipers
- 2010–2012 **Bachelor of Electrical Engineering**
University of Michigan, Ann Arbor, USA, *GPA – 4.00/ 4.00*
- 2008–2012 **Bachelor of Electrical and Computer Engineering**
Shanghai Jiao Tong University, Shanghai, China, *GPA – 3.87/ 4.00*

Awards & Honors

- 2019 Best Paper Award at High Accuracy Mobile Manipulation workshop, ICRA 2019
- 2017 3rd Place in Engineering Graduate Symposium at University of Michigan
- 2012 James B. Angell Scholar at University of Michigan
- 2010–2011 Dean's List at University of Michigan

Research Experience

- 2019–
Present **Learning Perceivable and Actionable Object Affordances for Manipulation**
UNIVERSITY OF MICHIGAN, Laboratory for Progress
ICRA19' Workshop
- Led a team of 6 people to develop a novel representation named Affordance Coordinate Frame (*ACF*) that bridges the gap between perception and manipulation
 - Investigated deep neural networks to generalize *ACF* localization across novel object instances in real-world cluttered scene
- 2018–
Present **Perception for Cluttered Bin Picking**
UNIVERSITY OF MICHIGAN, Laboratory for Progress
- Managed a team of 4 people to develop 6 DoF pose estimation of industrial parts in cluttered bins
 - Delivered a plug-and-play suite for pose estimation benchmarks
- 2018–2019 **Active Visual Object Search Based on Semantic Linking Maps**
UNIVERSITY OF MICHIGAN, Laboratory for Progress
ICRA20', ICRA19' Best Paper Award at HAMM workshop
- Developed an efficient particle filtering based algorithm for objects belief update with inter-object spatial dependencies during object search with a mobile robot
 - Modeled inter-object spatial relations based on long-term memory, short-term memory, and common-sense knowledge via a factor graph for spatial reasoning
 - Designed an object search strategy that outperformed state of the art methods with $\times 1.5$ speedup

2017–2018 **Contextual-Temporal Semantic Mapping for Cluttered Scenes at Scale**

UNIVERSITY OF MICHIGAN, Laboratory for Progress

IROS 18'

- Developed an online semantic mapping approach based on probabilistic graphical model to simultaneously detect and estimate objects 6 DoF poses in RGB-D videos
- Introduced an efficient particle-based belief propagation method to update objects class and pose belief
- Improved 26% on object detection accuracy and 70% on object pose estimation over benchmark methods for indoor semantic mapping on a mobile robot

2016–2017 **Semantic Robot Programming for Goal-Directed Manipulation**

UNIVERSITY OF MICHIGAN, Laboratory for Progress

ICRA18', IROS17', RSS17' Workshop

- Proposed a semantic robot programming approach that enable users to declaratively program robots by demonstrating goal scenes
- Developed a robust perception method for 6 DoF object pose estimation under uncertainty in cluttered scene by combining discriminative deep neural network and generative Bayesian inference
- Enabled users to program a Fetch robot to setup kitchen trays with various groceries and outperformed state of the art pose estimation method by 20% increase in accuracy and $\times 4.7$ speedup

2013–2015 **Object Manipulation Learning by Imitation through Reinforcement Learning**

UNIVERSITY OF MICHIGAN, The Intelligent Robotics Lab

- Enabled robots to improve demonstrated manipulation trajectories modeled by dynamic movement primitives through a policy gradient method
- Demonstrated a Baxter robot learning to stack objects by imitation with manipulation success rate improved from 60% to 90% within 45 trials

2014 **MRI Bias Field Correction Based on Tissue Labeling**

UNIVERSITY OF MICHIGAN, Best Student Project Award

- Proposed an algorithm that jointly labels tissues and corrects bias field in MRI images based on supervised learning on tissue segmentation
- Achieved a boost of 50% performance in tissue labeling and over 40% improvement on bias correction compared to benchmark methods when a strong bias field is present

Selected Projects

2017–2018 **Autonomous Snack Delivery with Mobile Manipulators**

UNIVERSITY OF MICHIGAN, Laboratory for Progress

- Coordinated a team of 12 people to develop an autonomous snack delivery system with Fetch robots
- Developed a behavior tree based reactive robot control architecture for mobile manipulations

2011 **Real-Time Gesture Recognition for Human-Computer Interaction**

UNIVERSITY OF MICHIGAN

- Developed a Bayesian filtering based real-time gesture recognition with precision at 80%

Publications

2020 **Semantic Linking Maps for Active Visual Object Search**

Zhen Zeng, Adrian Röfer, and Odest Chadwicke Jenkins

In *IEEE International Conference on Robotics and Automation (ICRA)*, 2020.

- 2019 **Generalized Object Permanence for Object Retrieval through Semantic Linking Maps**
 Zhen Zeng, Adrian Röfer, Shiyang Lu, and Odest Chadwicke Jenkins
 In *IEEE International Conference on Robotics and Automation (ICRA) Workshop*, 2019.
Best Paper Award
- Unsupervised Learning of Affordance Coordinate Frame for Robotic Task Generalization**
 Zhen Zeng, Pranav Suhas Joshi, and Odest Chadwicke Jenkins
 In *IEEE International Conference on Robotics and Automation (ICRA) Workshop*, 2019.
- 2018 **Semantic Mapping with Simultaneous Object Detection and Localization**
 Zhen Zeng, Yunwen Zhou, Odest Chadwicke Jenkins, and Karthik Desingh
 In *IEEE/RSJ International Conference on Intelligent Robots and Systems(IROS)*, 2018.
- Semantic Robot Programming for Goal-Directed Manipulation in Cluttered Scenes**
 Zhen Zeng, Zheming Zhou, Zhiqiang Sui, and Odest Chadwicke Jenkins
 In *IEEE International Conference on Robotics and Automation(ICRA)*, 2018.
- 2017 **Sum: Sequential Scene Understanding and Manipulation**
 Zhiqiang Sui, Zheming Zhou, Zhen Zeng, and Odest Chadwicke Jenkins
 In *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2017.
- Robot Programming by Goal Scene Demonstration**
 Zhen Zeng, Zheming Zhou, Zhiqiang Sui, and Odest Chadwicke Jenkins
 In *Robotics: Science and Systems (RSS) Workshop*, 2017.
- 2016 **Object Manipulation Learning by Imitation**
 Zhen Zeng, and Benjamin Kuipers
 In *ArXiv preprint. arXiv:1603.00964*, 2016.

Teaching Experience

- 2016 **Robotic System Laboratory**
 Graduate Student Instructor, Robotics Institute, University of Michigan
- 2017 **Robot Kinematics and Dynamics**
 Graduate Student Instructor, Robotics Institute, University of Michigan
- 2017 **Autonomous Robotics Laboratory**
 Graduate Student Instructor, EECS Department, University of Michigan

Skills

Programming C++, C, Python, Javascript, Matlab, Java
 Tools ROS, PCL, OpenCV, PyTorch, L^AT_EX
 Others [RELATE](#) public communication skills

Professional Service

Reviewer IEEE Robotics and Automation Letters (RA-L)
 AAAI Conference on Artificial Intelligence
 Robotics: Science and Systems Conference (RSS)

IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
IEEE-RAS International Conference on Humanoid Robots (Humanoids)
European Conference on Computer Vision (ECCV)
International Conference on Computer Vision Systems (ICVS)
Program Committee 4th International IEEE Workshop on 3D Representation and Recognition, IEEE International Conference on Computer Vision (ICCV), 2013

Talks

Generalized Object Permanence for Object Retrieval through Semantic Linking Maps

In 14th Annual New England Manipulation Symposium (NEMS), Columbia University, NY, 2019

Learning Affordance Coordinate Frame for Robotic Task Generalization

In 2nd International Workshop on Computational Models of Affordance in Robotics (ICRA), Montréal, Canada, 2019

Generalized Object Permanence for Object Retrieval through Semantic Linking Maps

In High Accuracy Mobile Manipulation in Challenging Environments (ICRA), Montréal, Canada, 2019

CT-Map: Contextual-Temporal Semantic Mapping for Cluttered Scenes

In Amazon Graduate Research Symposium, Seattle, 2019

Scaled Semantic Robot Programming in Cluttered Scenes

In National Robotics Initiative (NRI) PI Meeting, Arlington, 2018

Semantic Mapping with Simultaneous Object Detection and Localization

In IROS, Madrid, Spain, 2018

Semantic Robot Programming for Goal-Directed Manipulation in Cluttered Scenes

In ICRA, Brisbane, Australia, 2018

Robot Programming by Goal Scene Demonstration

In Human-Centered Robotics: Interaction, Physiological Integration and Autonomy (RSS), Cambridge, 2017

Scene-level Programming by Demonstration

In 12th Annual New England Manipulation Symposium (NEMS), Northeastern University, Boston, 2017

Everyone Can Teach a Robot

In Nerd Nite, Ann Arbor, 2015