Zhen Zeng

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Education

2012-2019 **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

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–Now **Perceivable and Actionable Object Affordances Learning for Robotic Manipulations**
University of Michigan, Laboratory for Progress, *(ICRA 2019 Workshop).*
- Proposed a novel representation of object affordances in the form of Affordance Coordinate Frame (*ACF*) that can be localized in point cloud of novel object instances and is associated with manipulation policy
- Proposed a *ACF* localization method based on PointNet neural network architecture
- Designed a loss function for learning *ACF* based on manipulation demonstrations of robot end-effector trajectories without requiring manual labeling of *ACF*

2018–Now **Deep Learning and 3D Registration for Cluttered Bin Picking**
University of Michigan, Laboratory for Progress.
- Led a team of 4 people to develop a Deep Learning based 6DoF pose estimation pipeline of industrial texture-less objects in cluttered bins.
- Developed an auto-encoder for object orientation estimation based on synthetic data with domain randomization.
- Achieved cycle time less than 1 s and provided at least 1 localized part within error range of 10 mm and 6° for each cluttered bin.
- Delivered a suite of 3D registration methods and a plug and play infrastructure for benchmarks.

2016–Now **Declarative Robot Programming by Demonstration in Large Scale Environments**

UNIVERSITY OF MICHIGAN, Laboratory for Progress.

- *Semantic Robot Programming (SRP) in Cluttered Scenes (ICRA 2018, RSS Workshop 2017)*
  - Proposed and developed *SRP* that enable end-users to intuitively program robots by demonstrating goal scenes
  - Developed robust 6DoF object pose estimation under uncertainty in cluttered scene by combining discriminative object detection based on Faster R-CNN and generative Bayesian inference.
  - Demonstrated the efficacy of *SRP* on a variety of tasks with end users programming a Fetch robot to setup kitchen trays with various groceries.
- *Online Semantic Mapping in Large Scale Environments (IROS 2018)*
  - Developed an online semantic mapping approach based on probabilistic graphical model to simultaneously detect and localize objects given RGB-D observations.
  - Proposed an efficient inference algorithm as a variant of particle-based belief propagation to recursively update the belief of objects classes and 6DoF poses in large scale environments.
  - Evaluations on a mobile robot semantically mapping indoor environments show 26% improvement on object detection accuracy and 70% improvement compared to benchmark methods.
- *Active Visual Object Search Based on Generalized Object Permanence (ICRA 2019 Best Paper Award at HAMM Workshop, ICRA 2020 Under Review)*
  - Modeled a generalized notion of object permanence through a parameterized Conditional Random Field for robots to maintain the belief over objects locations when they are not within sensor field of view
  - Developed a factor graph that reasons about long-term, short-term memory, and common-sense knowledge on inter-object spatial relations to predict scene layouts for long-term deployment of robots
  - Designed a novel active visual object search strategy that outperform state of the art methods with an average speedup of 20%

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

UNIVERSITY OF MICHIGAN, The Intelligent Robotics Lab.

- *Learning Robot Behavior Representation on Manipulation Tasks by Imitation*
  - Designed an algorithm based on Hidden Markov Model to automatically segment human demonstrations on object manipulation tasks into atomic actions
  - Developed an approach to adaptively formulate reinforcement learning problems around segmented atomic actions
  - Developed a robust 6DoF tracking system of cuboid objects in RGB-D streaming observations
- *Object Manipulation Policy Learning by Imitation*
  - Provided a robot manipulation learning system by imitation through reinforcement learning on a parameterized Dynamic Movement Primitive that generates robot end-effector trajectories
  - Evaluations on a Baxter robot learning to stack objects by imitation showed an improvement of manipulation success rate from 60% to 90% within 45 trials

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

UNIVERSITY OF MICHIGAN, EECS 556 Best 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 algorithms when a strong bias field is present.

Selected Projects

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

UNIVERSITY OF MICHIGAN, Laboratory for Progress.

- Led a team of 12 people to develop an autonomous snack delivery system with Fetch robots
- Developed communication bridges between LCM and ROS to autonomously navigate robots in environments with crowd and glass walls
- Developed a reactive robot control architecture for mobile manipulations based on behavior trees

2011 **Real-Time Gesture Recognition for Human-Computer Interaction**
University of Michigan.
- Designed a novel fingertip detection algorithm for hand gesture classification
- Developed a Bayesian filtering approach for real-time gesture recognition with precision at 80%

Teaching Experience

2016 **Graduate Student Instructor, ROB 550 – Robotic System Laboratory**
University of Michigan, Robotics Institute.

2017 **Graduate Student Instructor, ROB 510 – Robot Kinematics and Dynamics**
University of Michigan, Robotics Institute.

2017 **Graduate Student Instructor, EECS 467 – Autonomous Robotics Laboratory**
University of Michigan, EECS Department.

Skills

Programming C++, C, Python, Javascript, Matlab, Java

Tools ROS, PCL, OpenCV, PyTorch, LaTeX, Microsoft Office

Others RELATE training of public communication skills to lay audiences

Publications

1. Zhen Zeng, Adrian Röfer, and Odest Chadwicke Jenkins. Semantic linking maps for active visual object search. In *2020 IEEE International Conference on Robotics and Automation (ICRA)*. IEEE, 2020. **Under review**.
2. Zhen Zeng, Yunwen Zhou, Odest Chadwicke Jenkins, and Karthik Desingh. Semantic mapping with simultaneous object detection and localization. In *2018 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pages 911–918. IEEE, 2018.
3. Zhen Zeng, Zheming Zhou, Zhiqiang Sui, and Odest Chadwicke Jenkins. Semantic robot programming for goal-directed manipulation in cluttered scenes. In *2018 IEEE International Conference on Robotics and Automation (ICRA)*, pages 7462–7469. IEEE, 2018.
4. Zhiqiang Sui, Zheming Zhou, Zhen Zeng, and Odest Chadwicke Jenkins. Sum: Sequential scene understanding and manipulation. In *2017 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pages 3281–3288. IEEE, 2017.
5. Zhen Zeng, Pranav Suhas Joshi, and Odest Chadwicke Jenkins. Unsupervised learning of affordance coordinate frame for robotic task generalization. *2019 IEEE International Conference on Robotics and Automation (ICRA) Workshop*, 2019.
6. Zhen Zeng, Adrian Röfer, Shiyang Lu, and Odest Chadwicke Jenkins. Generalized object permanence for object retrieval through semantic linking maps. *2019 IEEE International Conference on Robotics and Automation (ICRA) Workshop*, 2019. ***Best Paper Award***.
7. Zhen Zeng, Zheming Zhou, Zhiqiang Sui, and Odest Chadwicke Jenkins. Robot programming by goal scene demonstration. *2017 Robotics: Science and Systems (RSS) Workshop*, 2017.
8. Zhen Zeng and Benjamin Kuipers. Learning tabletop object manipulation by imitation. *arXiv preprint arXiv:1603.00964*, 2016.