

Alex Zihao Zhu

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EDUCATION

University of Pennsylvania

PhD, Computer and Information Science

August 2014-December 2019

Master of Science in Engineering in Robotics

August 2014-May 2016

Advisor: Dr. Kostas Daniilidis

Duke University

August 2010-May 2014

Bachelor of Science in Engineering, magna cum laude

Majors: Electrical and Computer Engineering and Computer Science

Advisor: Dr. Michael Zavlanos

Robertson Scholar, Class of 2014

RESEARCH INTERESTS

Computer vision and robotics, with special interests in event-based cameras, 3D perception and self-supervised and unsupervised deep learning methods.

PUBLICATIONS

[14] K. Chaney, **A.Z. Zhu**, K. Daniilidis, **Learning Event-based Height from Plane and Parallax**, *International Conference on Intelligent Robots and Systems (IROS) 2019*.

[13] **A.Z. Zhu**, L. Yuan, K. Chaney, K. Daniilidis, **Unsupervised Event-based Learning of Optical Flow, Depth, and Egomotion**, *Conference on Computer Vision and Pattern Recognition (CVPR) 2019*.

[12] **A.Z. Zhu***, W. Liu*, Z. Wang, K. Daniilidis, **Robustness Meets Deep Learning: An End-to-End Hybrid Pipeline for Unsupervised Learning of Egomotion**, *Conference on Computer Vision and Pattern Recognition (CVPR) 2019, Workshop on Deep Learning for Semantic Visual Navigation*.

[11] K. Chaney, **A.Z. Zhu**, K. Daniilidis, **Learning Event-based Height from Plane and Parallax**, *Conference on Computer Vision and Pattern Recognition (CVPR) 2019, Event-based Vision Workshop*.

[10] **A.Z. Zhu**, Y. Chen, K. Daniilidis, **Realtime Time Synchronized Event-based Stereo**, *European Conference on Computer Vision (ECCV) 2018*.

[9] **A.Z. Zhu**, L. Yuan, K. Chaney, K. Daniilidis, **Unsupervised Event-based Optical Flow using Motion Compensation**, *European Conference on Computer Vision (ECCV) 2018, What is Optical Flow For? Workshop*. Also presented as a live demo session.

[8] **A.Z. Zhu**, L. Yuan, K. Chaney, K. Daniilidis, **EV-FlowNet: Self-Supervised Optical Flow Estimation for Event-based Cameras**, *Robotics: Science and Systems (RSS) 2018*. **Best Student Paper Finalist, 1 of 3**.

[7] **A.Z. Zhu**, D. Thakur, T. Özaslan, B. Pfrommer, V. Kumar, K. Daniilidis, **The Multi-Vehicle Stereo Event Camera Dataset: An Event Camera Dataset for 3D Perception**, *IEEE Robotics and Automation Letters (RA-L) 2018*, presented at *IEEE International Conference on Robotics and Automation (ICRA) 2018*.

[6] K. Mohta, M. Watterson, ..., **A.Z. Zhu**, et al., **Fast, Autonomous Flight in GPS-Denied and Cluttered Environments**, *Journal of Field Robotics* 15 Dec 2017.

[5] **A.Z. Zhu**, N. Atanasov, K. Daniilidis, **Event-based Visual Inertial Odometry**, *Conference on Computer Vision and Pattern Recognition (CVPR) 2017*.

[4] C. Freundlich, Y. Zhang, **A.Z. Zhu**, P. Mordohai, M. Zavlanos, **Controlling a Robotic Stereo Camera Under Image Quantization Noise**, *The International Journal of Robotics Research* 22 Oct 2017.

[3] **A.Z. Zhu**, N. Atanasov, K. Daniilidis, **Event-based Feature Tracking with Probabilistic Data Association**, *IEEE International Conference on Robotics and Automation (ICRA) 2017*.

[2] S. Farhadi, R. P. Behringer, **A.Z. Zhu**, **Stress Relaxation for Granular Materials near Jamming Under Cyclic Compression**, *Physical Review Letters 29 Oct 2015*.

[1] S. Farhadi, R. P. Behringer, **A.Z. Zhu**, **Slow Dynamics for Elliptical Particles under Continuous Shear and Cyclic Compression**, *Powders and Grains 2013*.

PREPRINTS

[2*] **A.Z. Zhu**, Z. Wang, K. Khant, K. Daniilidis, **EventGAN: Leveraging Large Scale Image Datasets for Event Cameras**, *In submission, 2019*.

[1*] **A.Z. Zhu**, Z. Wang, K. Daniilidis, **Motion Equivariant Networks for Event Cameras with the Temporal Normalization Transform**.

RELEVANT EXPERIENCE

Waymo LLC. Mountain View, California
Researcher January 2020-Current

- Member of the research team developing algorithms to improve deep learning for self driving cars.

Zoox Inc. Menlo Park, California
3D Perception Intern May 2017-August 2017

- Developed a nonlinear optimization algorithm for 3D tracking of objects from multiple sensing modalities such as cameras, lidar and radar for autonomous vehicles.

GRASP Lab Philadelphia, Pennsylvania
Doctoral Student August 2014-December 2019

Research

- Developing novel algorithms for event-based cameras to solve motion estimation tasks in difficult scenes such as high speed motions and challenging lighting.

DARPA Fast Lightweight Autonomy Program

- Developing algorithms for high speed flight using event based cameras, with an end goal of flying a quadrotor at up to 20m/s through cluttered environments.

Glaxo Smith Kline Lab Automation

- Developed a full pipeline for transparent object detection and visual servoing based grasping and manipulation using the Baxter robot in a long term project to automate chemical laboratories.

DARPA Robotics Challenge

- Developed a stereo vision based obstacle map generator for a teleoperated driving task for Team Trooper (in conjunction with Lockheed Martin). Driving task was successfully completed on both days.

Robotics Collaborative Technology Alliance (RCTA)

- Developed software pipelines for 3D object pose estimation.

Duke Robotics and Manufacturing Automation Laboratory Durham, North Carolina
Pratt Engineering Undergraduate Research Fellow January 2013 - May 2014

- Developed a stereo-camera system mounted on an iRobot Create for implementing a new formulation to the Next Best View problem to improve 3-D reconstruction quality.

INVITED TALKS

Event Camera Research at the University of Pennsylvania, Samsung AI Center New York, March 2019.

Unsupervised Event-based Learning of Optical Flow, Depth and Egomotion, Intel Neuromorphic Research Community (INRC) Winter Workshop, January 2019.

Computer Vision Approaches for Event-based Cameras, Telluride 2018 Neuromorphic Cognition Engineering Workshop, July 2018.

SKILLS

Software and Frameworks: Tensorflow, PyTorch, Ceres Solver, ROS, OpenCV, PCL, Numpy.

Programming Languages: Python, C++, MATLAB, JAVA.

HONORS AND AWARDS

Robotics: Science and Systems Best Student Paper Finalist (1 of 3) (2018)

Robertson Scholar, Class of 2014

The Robertson Scholarship is a full merit scholarship program at Duke University and the University of North Carolina at Chapel Hill.

Phi Beta Kappa National Honor Society (2015)

Duke ECE Outstanding Undergraduate Teaching Assistants Award (2014)

Tau Beta Pi National Honor Society (2013)

Eta Kappa Nu National Honor Society (2013)

Institution of Professional Engineers New Zealand Foundation Scholarship (2010)

PEER REVIEWS

AAAI Conference on Artificial Intelligence 2020

Conference on Computer Vision and Pattern Recognition (CVPR) 2019

International Conference on Computer Vision (ICCV) 2019

International Conference on Robotics and Automation (ICRA) 2018, 2019, 2020

International Conference on Intelligent Robots and Systems (IROS) 2018, 2019

International Conference on 3D Vision (3DV) 2019

Winter Conference on Applications of Computer Vision (WACV) 2019, 2020

IEEE Robotics and Automation Letters (RA-L) 2019

IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI) 2018, 2019

Pattern Recognition Letters (PRL) 2018, 2019

Autonomous Robots (AURO) 2019

TEACHING EXPERIENCE

MEAM 620 - Advanced Robotics

University of Pennsylvania

Lecturer

January 2016-Present

Shared lecturing load for a course in quadrotor control and perception, with topics in path planning, controls and visual odometry. Students mainly completed projects, both in simulation and on hardware, that allowed for fully autonomous flight of a quadrotor.

Coursera - Robotics Specialization: Capstone

University of Pennsylvania

Lecturer

March 2016-March 2017

Developed an online course where students build and program their own autonomous rover, including six weeks of lectures and assignments, and a full ROS stack for control of a Raspberry Pi based rover with onboard camera and IMU. Students implement a vision based controller, EKF and path planner for autonomous navigation.

Coursera - Robotics Specialization: Perception

University of Pennsylvania

Teaching Assistant

March 2016-May 2016

Developed assignments for a six week online course where students learn the fundamentals for robot perception. Topics covered include projective, two-view and multi-view geometry.

CIS 390 - Robotics: Planning and Perception

University of Pennsylvania

Teaching Assistant

August 2015-December 2015

Developed a new upper level undergraduate course in robotics, focusing mainly in autonomous planning and navigation. Responsible for developing weekly homeworks, as well as developing a new robotic platform consisting of an iRobot Create 2 with Raspberry Pi and camera on board. Students implemented basic path planning and filtering algorithms, both in software and on the hardware platform, allowing for autonomous navigation.

ECE 280L - Introduction to Signals and Systems

Duke University

Head Teaching Assistant

August 2013-May 2014

Led a team of TAs for signals processing labs, with projects such as synthesizing music from waveforms and creating AM radios.