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Chiho Choi, Ph.D.

CONTACT INFROMATION

Honda Research Institute USA Inc.
70 Rio Robles, San Jose, CA 95134
chihochoi@outlook.com

Website
LinkedIn
Google Scholar

RESEARCH INTERESTS

My research interests span the fields of *computer vision*, *machine learning*, and *robotics*, focusing on understanding and prediction of human behavior in highly interactive environments. In this area, I build a new perspective for the safe operation of autonomous systems designed to cooperate with humans.

- Behavior Reasoning
- Motion Prediction
- Activity Forecasting
- Relational Inference
- Uncertainty Modeling
- Interactive Planning
- Human Pose Prediction
- Pose Estimation

WORK EXPERIENCE

Honda Research Institute (HRI) USA — San Jose, CA, USA
Senior Scientist — July 2021 – Present
- Leading multiple projects on understanding of human action, intention, and future behavior.

Scientist — February 2018 – June 2021
- Worked on recognition, reasoning, and prediction of human states and behaviors in multi-agent interacting environments.

HERE Technologies — Chicago, IL, USA
Intern — May 2017 – August 2017
- Worked on traffic scene understanding (detection and recognition) for automated driving.
- Proposed a solution to learn from imbalanced data for generic machine learning systems.
- Supervisor: Dr. Xiang Ma and Prof. Xin Chen

EDUCATION

Purdue University — West Lafayette, IN, USA
Ph.D., Electrical and Computer Engineering — January 2018
- Specialization: deep learning, 3D vision, recognition, tracking
- Committee members: Karthik Ramani, Stanley H. Chan, Mireille Boutin, Jeffrey M. Siskind

University of Southern California — Los Angeles, CA, USA
M.S., Electrical Engineering — May 2013
- Specialization: 3D shape matching, registration
- Advisor: Prof. Suya You, Department of Computer Science

Hanyang University — Seoul, Korea
B.S., Electronics and Computer Engineering — February 2011
- Minor: Mechanical Engineering

PUBLICATIONS

I have published 17 peer-reviewed papers (13 as a first or corresponding author) in the field of Computer

Vision (CVPR – 2 oral & 1 poster, ICCV – 6 posters), Machine Learning (NeurIPS, ICLR), Robotics (ICRA, IROS, CoRL), and Control (ACC). The full list of papers is as follows:

Refereed Papers

[C17] H. Girase*, H. Gang*, S. Malla, J. Li, A. Kanehara, K. Mangalam, and **C. Choi**. "LOKI: Long Term and Key Intentions for Trajectory Prediction". *In Proceedings of the IEEE International Conference on Computer Vision (**ICCV**) 2021*, to appear.

[C16] J. Li, F. Yang, H. Ma, S. Malla, M. Tomizuka, and **C. Choi**. "RAIN: Reinforced Hybrid Attention Inference Network for Motion Forecasting". *In Proceedings of the IEEE International Conference on Computer Vision (**ICCV**) 2021*, to appear.

[C15] **C. Choi***, J. H. Choi*, J. Li, and S. Malla "Shared Cross-Modal Trajectory Prediction for Autonomous Driving". *In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (**CVPR**) 2021,* **Oral presentation** (4.2% acceptance rate). *arXiv: 2011.08436*

[C14] S. Malla, **C. Choi**, and B. Dariush "Social-STAGE: Spatio-Temporal Multi-Modal Future Trajectory Forecast". *In Proceedings of the IEEE International Conference on Robotics and Automation (**ICRA**) 2021. arXiv: 2011.04853*

[C13] J. Li, F. Yang, M. Tomizuka, and **C. Choi**. "EvolveGraph: Multi-Agent Trajectory Prediction with Dynamic Relational Reasoning". *In Proceedings of the Conference on Neural Information Processing Systems (**NeurIPS**) 2020. arXiv: 2003.13924*

[C12] **C. Choi**, S. Malla, A. Patil, and J. H. Choi. "DROGON: A Trajectory Prediction Model based on Intention-Conditioned Behavior Reasoning". *In Proceedings of the Conference on Robot Learning (**CoRL**) 2020. arXiv:1908.00024*

[C11] I. Dwivedi, S. Malla, B. Dariush, and **C. Choi**. "SSP: Single Shot Future Trajectory Prediction". *In Proceedings of the IEEE International Conference on Intelligent Robots and Systems (**IROS**) 2020. arXiv: 2004.05846*

[C10] S. Malla, B. Dariush, and **C. Choi**. "TITAN: Future Forecast using Action Priors". *In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (**CVPR**) 2020,* **Oral presentation** (5.7% acceptance rate). *arXiv:2003.13886*

[C9] S. Bae, D. Saxena, A. Nakhaei, **C. Choi**, K. Fujimura, and S. Moura. "Cooperation-Aware Lane Change Maneuver in Dense Traffic based on Model Predictive Control with Recurrent Neural Network". *In Proceedings of the American Control Conference (**ACC**) 2020. arXiv:1909.05665*

[C8] **C. Choi** and B. Dariush. "Looking to Relations for Future Trajectory Forecast". *In Proceedings of the IEEE International Conference on Computer Vision (**ICCV**) 2019. arXiv: 1905.08855*

[C7] **C. Choi** and B. Dariush. "Learning to Infer Relations for Future Trajectory Forecast". *In the IEEE Conference on Computer Vision and Pattern Recognition (**CVPR**) Workshops 2019.*

[C6] Y. Yao, M. Xu, **C. Choi**, D. Crandall, E. Atkins, and B. Dariush. "Egocentric Vision-based Future Vehicle Localization for Intelligent Driving Assistance Systems". *In Proceedings of the IEEE International Conference on Robotics and Automation (**ICRA**) 2019.*

[C5] M. Liu, F. Yao, **C. Choi**, A. Sinha, and K. Ramani. "Deep Learning 3D Shapes Using Alt-az Anisotropic 2-Sphere Convolution". *In Proceedings of the International Conference on Learning Representations (**ICLR**) 2019.*

[C4] **C. Choi**, S. Kim, and K. Ramani. "Learning Hand Articulations by Hallucinating Heat Distribution". *In Proceedings of the IEEE International Conference on Computer Vision (**ICCV**) 2017.*

[C3] **C. Choi**, S. H. Yoon, C. N. Chen, and K. Ramani. "Robust Hand Pose Estimation during the Interaction with an Unknown Object". *In Proceedings of the IEEE International Conference on Computer Vision (**ICCV**) 2017.*

[C2] **C. Choi***, A. Sinha*, and K. Ramani (* Co-first Author, order changed for emphasis). "DeepHand:

Robust Hand Pose Estimation by Completing a Matrix Imputed with Deep Features". *In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (**CVPR**) 2016.*

[C1] **C. Choi**, A. Sinha, J. H. Choi, S. Jang, and K. Ramani. "A Collaborative Filtering Approach to Real-Time Hand Pose Estimation". *In Proceedings of the IEEE International Conference on Computer Vision (**ICCV**) 2015.*

Non-Refereed Papers

[T4] S. Su, C. Peng, J. Shi, and **C. Choi**. "Potential Field: Interpretable and Unified Representation for Trajectory Prediction". *November 2019. arXiv:1911.07414*

[T3] S. Malla, I. Dwivedi, B. Dariush, and **C. Choi**. "NEMO: Future Object Localization Using Noisy Ego Priors". *September 2019. arXiv:1909.08150*

[T2] **C. Choi**, S. Kim, J. H. Choi, and K. Ramani. "Embedding Compressive Layers in Deep Neural Networks". *Technical Report, Purdue University, May 2017.*

[T1] **C. Choi** and S. You. "Dense and Reliable Shape Matching using 3D Particle Filtering". *Technical Report, University of Southern California, May 2013.*

Thesis

[D1] **C. Choi**. "Computational Learning for Hand Pose Estimation". *Ph.D. Dissertation, Purdue University, Jan 2018.*

PATENT APPLICATIONS

[P21] J. Li, H. Gang, H. Ma, and **C. Choi**. "System and Method for Important Object Identification with Semi-Supervised Learning". Application pending.

[P20] H. Girase, H. Gang, S. Malla, J. Li, A. Kanehara, and **C. Choi**. "System and Method for Providing Long Term Key Intentions for Trajectory Prediction". Application pending.

[P19] H. Ma, J. Li, and **C. Choi**. "System and Method for Completing Continual Multi-Agent Trajectory Forecasting". Application pending.

[P18] **C. Choi**, S. Malla, and S. Bae. "System and Method for Completing Trajectory from Agent-Augmented Environments". Application pending.

[P17] J. Li and **C. Choi**. "System and Method for Reinforced Hybrid Attention for Motion Forecasting". Application pending.

[P16] S. Malla, **C. Choi**, and B. Dariush. "System and Method for Providing Social-Stage Spatio-Temporal Multi-Modal Future Forecasting". Application pending.

[P15] **C. Choi**. "System and Method for Shared Cross-Modal Trajectory Prediction". Application pending.

[P14] J. Li and **C. Choi**. "Systems and Methods for Heterogeneous Multi-Agent Multi-Modal Trajectory Prediction with Evolving Interaction Graphs". Application pending.

[P13] I. Dwivedi, S. Malla, **C. Choi**, and Behzad Dariush. "System for Single Shot Prediction using Composite Fields and Method Thereof". Application pending.

[P12] S. Malla, **C. Choi**, and Behzad Dariush. "System and Method for Future Forecasting using Action Priors". Application pending.

[P11] S. Su and **C. Choi**. "System and Method for Providing an Interpretable and Unified Representation for Trajectory Prediction". Application pending.

[P10] A. Nakhaei, K. Fujimura, **C. Choi**, S. Bae, D. Saxena. "System and Method for Providing Cooperation-Aware Lane Change Control in Dense Traffic". US 16/844331

[P9] S. Malla and **C. Choi**. "System and Method for Providing Future Object Localization". US 16/828343

[P8] **C. Choi**. "Trajectory Prediction". No. 16/524821

[P7] Y. Yao, M. Xu, **C. Choi**, and B. Dariush. "System and Method for Egocentric-vision based Future Vehicle Localization". Publication No. 16/386964

[P6] **C. Choi**. "Methods and Apparatuses for Future Trajectory Forecast". US 11/062141

[P5] X. Chen, X. Ma, S. Sood, and **C. Choi**. "Semi-automatic Training Data Selection based on High-dimensional Data Projection to Subspaces". Application pending.

[P4] X. Chen, X. Ma, S. Sood, and **C. Choi**. "Deep Neural Machine for Lane Marking Style Classification based on Unwrapped Perspective Images". Application pending.

[P3] X. Chen, X. Ma, S. Sood, and **C. Choi**. "Deep Neural Machine for Lane Marking Color and Material Classification based on Image Patches". Application pending.

[P2] A. Sinha, **C. Choi**, J. H. Choi, and K. Ramani. "Method of training neural networks for hand pose detection". US 10/503270

[P1] A. Sinha, **C. Choi**, J. H. Choi, and K. Ramani. "Method and System for Hand Pose Estimation". US 10/318008

TEACHING EXPERIENCE

Students Supervised

- Reza Ghoddoosian (Ph.D.), from University of Texas, Arlington — May 2021 – Present
- Ramtin Hosseini (Ph.D.), from Tufts University — May 2021 – Present
- Hengbo Ma (Ph.D.), from University of California, Berkeley — January 2021 – Present
- Harshayu Girase (M.S.), from University of California, Berkeley — January 2021 – Present
- Jiachen Li (Ph.D.), from University of California, Berkeley — September 2019 – May 2021
- Crane He Chen (Ph.D.), from Johns Hopkins University — January 2021 – April 2020
- Shan Su (Ph.D.), from University of Pennsylvania — July 2019 – December 2020
- Sangjae Bae (Ph.D.), from University of California, Berkeley — May 2020 – August 2020; June 2019 – September 2019
- Yu Yao (Ph.D.), from University of Michigan — May 2018 – August 2018

Teaching Assistant

- Purdue University — January 2015 – May 2015
  ME 444: Computer-aided Design and Rapid Prototyping
  Introduction to advanced computer-aided design for product design, modeling, and prototyping.
- University of Southern California — August 2012 – December 2012
  CSCI 588 (graduate-level course): Specification and Design of User Interface Software
  A design and implementation of user interface software relating to human/computer interaction.

INVITED TALKS

Guest Lecturer, Purdue University — December 2017

- Introduction to Pose Estimation – Probabilistic models in computer vision

ACADEMIC SERVICES

Organizing Chair

- 1st Workshop on *Multi-Agent Relational Reasoning in Computer Vision* in conjunction with ICCV 2021

Publication Committee

- Honda Research Institute USA — February 2020 – Present

Program Committee / Reviewer

- International Conference on Learning Representations (ICLR) 2021, 2022

- IEEE Winter Conference on Applications of Computer Vision (WACV) 2021, 2022
- Conference on Neural Information Processing Systems (NeurIPS) 2020, 2021
- IEEE International Conference on Intelligent Robots and Systems (IROS) 2021
- IEEE International Conference on Computer Vision (ICCV) 2019, 2021
- International Conference on Machine Learning (ICML) 2021
- IEEE Conference on Computer Vision and Pattern Recognition (CVPR) 2018, 2019, 2020, 2021
- Association for Advancement of Artificial Intelligence (AAAI) 2020, 2021
- Asian Conference on Computer Vision (ACCV) 2018, 2020
- European Conference on Computer Vision (ECCV) 2020
- IEEE Intelligent Vehicles Symposium (IV) 2020
- ACM CHI Conference on Human Factors in Computing Systems (CHI) 2019

- IEEE Robotics and Automation Letters (RA-L)
- IEEE Transactions on Intelligent Vehicles (T-IV)
- IEEE Transactions on Image Processing (T-IP)
- IEEE Transactions on Multimedia (T-MM)

HORNORS

National Science and Technology Scholarship 2003 – 2010
from *Ministry of Education, Science and Technology*, Korea

MEDIA COVERAGE

- Looking to Relations for Future Trajectory Forecast, ICCV Daily Magazine, October 30, 2019.
- AI Can Predict the Future Location of Vehicles, NVIDIA NEWS Center, September 27, 2018.
- Freeing Our Fingers: Handing Over VR's Toughest Challenge to GPUs, NVIDIA Blog, August 24, 2016.
- AI and VR: New Experiments at Purdue University, ENGINEERING.com, June 30, 2016
- DeepHand motion tracking enters the VR arms race, New Atlas, June 23, 2016
- New tool for virtual and augmented reality uses 'deep learning', Purdue News, June 22, 2016.

REFERENCES

Available Upon Request