

Yuanzhi Cao

AUGMENTED REALITY HCI RESEARCHER · DESIGNER · MAKER

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As a senior Ph.D. student (advised by Prof. Karthik Ramani) and a researcher in the **Human-Computer Interaction (HCI)** area, I specialize in designing interactive systems that provide novel **Augmented Reality (AR)** user experience for smartthings applications, such as **Machines, Robots, and IoTS**.

Education

Purdue University

PH.D. IN C DESIGN LAB, MECHANICAL ENGINEERING DEPARTMENT

GPA : 3.86

West Lafayette, USA

Aug. 2015 - Dec. 2020

Indiana University – Purdue University Indianapolis (IUPUI)

M.S. IN MECHANICAL ENGINEERING DEPARTMENT

GPA : 3.91

Indianapolis, USA

Aug. 2013 - May. 2015

Dalian University of Technology (DLUT)

B.S. IN MECHANICAL ENGINEERING DEPARTMENT

GPA : 3.68

Dalian, China

Sep. 2008 - Jun. 2013

Research Experience

- HUMAN-ROBOT-IOT INTERACTION WITH AUGMENTED REALITY (**PH.D. THESIS**)

An Exploratory Study of Augmented Reality Presence for Tutoring Machine Tasks [C.7]

Purdue

LEAD AUTHOR

Published at CHI 2020

- Study system design and implementation of a machine task scenario to compare four different AR-based tutor options in parallel
- Quantitative and qualitative results showing users' objective and subjective responses and tutor preferences
- Recommendations and insights summarized from the results of the study, guiding future machine task tutoring system design

GhostAR: Time-space Editing for Human-Robot Collaborative Task Authoring [C.6]

Purdue

LEAD AUTHOR

Published at UIST 2019

- System workflow design with AR ghost as contextual references from role-playing natural embodied interaction, patents filed
- Collaboration model design that achieves time-space correlation based on the dynamic time warping (DTW) algorithm
- Interface and interaction design for ghost creation, visualization, editing, and previewing throughout a successful collaborative action

V.Ra: Visual and Spatial Programming for Robot Task Planning [C.5, A.3, H.6]

Purdue

LEAD AUTHOR

Published at DIS 2019, CHI LBW 2019

- System framework design with prototype human-robot-IoT ecosystem for robot task planning with one single SLAM-AR device
- Design and implementation of a mobile-based authoring interface that supports creating, editing, and simulating complex tasks
- Applied for 2 non-provisional patents [H.7, H.8] and commercialized by a start-up DIY modular robotics company, ZIRO [H.9]

Ani-Bot: A DIY Modular Robotics System Supporting Mixed Reality Interaction [C.2, A.2]

Purdue

LEAD AUTHOR

Published at TEI 2018, UIST poster 2017

- Design of the system workflow supporting Mixed Reality interaction for modular DIY robotics with HMD (HoloLens)
- Design and fabrication of modular DIY robotics kit (30 modules in total) embedded with assembly awareness
- Multi-modal Mixed Reality interactions enabling assembly and iteration guidance, and customization of complex tasks

- SPATIALITY EXPLORATION FOR SMARTTHINGS IN AUGMENTED REALITY

SynchronizAR: Instant Registration Between SLAM Based AR Systems [C.4]

Purdue

CO-AUTHOR

Published at UIST 2018

- Design of the algorithm allowing instant estimating relative 3D locations of two SLAM systems without sharing maps
- Implementation of the workflow that enables rapid collaborative among users and robots in the AR environment

ScenarIoT: Spatially Mapping IoT Devices within Augmented Scenes [C.3]

Purdue

CO-AUTHOR

Published at CHI 2018

- Design of the workflow estimating the spatial distribution of smartthings using a SLAM based AR device and UWB distance measurement units
- Development of a distance-based localization algorithm based on Multidimensional Scaling (MDS)
- Design of the spatial-aware user interactions enabled by smartthings rapidly mapped in the AR scenes

Professional Experience

Microsoft internship

RESEARCH INTERN AT APPLIED SCIENCE GROUP (ASG)

Redmond, USA

Jan. 2020 - May. 2020

- Designed and implemented a mobile augmented reality system for user-defined portrait relighting on smartphone
- Collaborated with the team to design the AR face illumination machine learning model and the integration with Android development
- Recommended by the manager for future publication and corporate production

WorldSkills Competition 2011

CHINESE TEAM CANDIDATE, SKILL OF **MECHANICAL ENGINEERING DESIGN - CAD**

London, England

Mar. 2011 - Oct. 2011

- Nationally selected into the training program and became the final three candidates for the international competition
- Contributed as the primary alternate for team China to win the *Medallion for Excellence* [H.2]
- Gained massive CAD experience and developed a fundamental understanding of becoming a good engineer and designer [H.3, H.4]

Honda Eco Mileage Challenge

TEAM LEADER & CHIEF DESIGNER

Dalian, China

Sep. 2009 - Oct. 2010

- Designed and manufactured two fuel-efficient vehicles powered by 200cc motorcycle engine (provided by Honda)
- Led university team *ForceDUT* and won the national first prize (6/72) with a result of 540 Km/Liter [H.1]
- Designed a fully-detailed concept vehicle as a digital reference for the future team, and used it for my senior design [H.4]

Teaching Experience

Computer Aided Design and Prototyping (ME444)

HEAD TEACHING ASSISTANT & PROJECT COACH

Purdue

2015-2018 Fall; 2017, 2018 Spring

- In charge of lab session and coached 50+ students with their CAD skills using PTC Creo
- Developed innovative guided-project oriented course content to help students improve their hands-on prototyping skills
- Gave selective lectures and demonstrations for *ideation through sketching*, *design for fabrication*, and *wireless mechatronics control*

Technical Skillset

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|--------------------------|---|
| Augmented Reality | Google ARCore/TangoCore, Microsoft Mixed Reality, Oculus Rift, HTC Vive, Vuforia, OpenCV |
| Machine Learning | TensorFlow, Linear Regression, K-Means Clustering, Support Vector Machines, Reinforcement Learning (Unity3D) |
| Prototyping | AR System Development (Unity3D), Robotics (ROS), IoT and Smart Machine (Arduino) |
| Design | Ideation Sketching, Mechanical Computer-Aided Design, Industrial Design, 3D Rendering and Visualization |
| Fabrication | 3D Printing, Laser Cutting, Hands-on Crafting, Tinkering, Soldering and Welding, CNC Machining |
| User Experience | Informative Elicitation Study, Iterative Design and Benchmark, Qualitative and Quantitative Evaluation and Analysis |

Academic Service

Reviewer CHI 2019-2020, UIST 2019, HRI 2018-2019, DIS 2018-2019, TEI 2018-2019

Volunteer UIST 2017, TEI 2018

Honors & Awards & Patents

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| [H.9] 2019 Inventor , Collaborated with ZIRO to embed our phone based authoring system into their commercial product | ZIRO, USA |
| [H.8] 2019 US Patent , Augmented reality interface for authoring tasks for execution by a programmable robot | Purdue, USA |
| [H.7] 2019 US Patent , Robot navigation and robot-IoT interactive task planning using augmented reality | Purdue, USA |
| [H.6] 2017 Best Implementation , Student contest at User Interface Software and Technology Symposium (UIST), 1/16 | Quebec, Canada |
| [H.5] 2015 Outstanding Thesis , Nominated as outstanding thesis and the recipient of University Fellowship, top 5% | IUPUI, USA |
| [H.4] 2013 Outstanding Senior Design , Digital prototype design of a conceptual eco-power vehicle, top 5% | DLUT, China |
| [H.3] 2012 1st Prize , National Digital Product Mechanical Design Competition, ranked 3/400 | Wuhan, China |
| [H.2] 2011 Medallion for Excellence , WorldSkills Competition, Mechanical Engineering Design - CAD | London, England |
| [H.1] 2010 1st Prize , National Honda Eco Mileage Challenge, ranked 6/72 | Guangzhou, China |

MAJOR CONFERENCE & JOURNAL & EXTENDED ABSTRACT & THESIS (PEER-REVIEWED)

- C.7** Y. Cao, X. Qian, T. Wang, R. Lee, K. Huo, K. Ramani, "An Exploratory Study of Augmented Reality Presence for Tutoring Machine Tasks", Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems (**CHI 2020**) (**23.8%** Acceptance Rate)
- C.6** Y. Cao, T. Wang, et al., and K. Ramani, "GhostAR: A Time-space Editor for Embodied Authoring of Human-Robot Collaborative Task with Augmented Reality", Proceedings of the 32nd Annual Symposium on User Interface Software and Technology (**UIST 2019**) (**24.4%** Acceptance Rate)
- C.5** Y. Cao, Z. Xu, et al., and K. Ramani, "V.Ra: An In-Situ Visual Authoring System for Robot-IoT Task Planning with Augmented Reality", Proceedings of the 2019 Designing Interactive Systems (**DIS 2019**) (**25%** Acceptance Rate)
- C.4** K. Huo, T. Wang, L. Paredes, A. Villanueva, Y. Cao and K. Ramani, "SynchronizAR: Instant Synchronization for Spontaneous and Spatial Collaborations in Augmented Reality", Proceedings of the 31st Annual Symposium on User Interface Software and Technology (**UIST 2018**) (**22.5%** Acceptance Rate)
- C.3** K. Huo, Y. Cao, S. Yoon, Z. Xu, G. Chen, K. Ramani, "Scenariot: Spatially Mapping Smart Things Within Augmented Reality Scenes", Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (**CHI 2018**) (**25%** Acceptance Rate)
- C.2** Y. Cao, Z. Xu, T. Glenn, K. Huo, K. Ramani, "Ani-Bot: A Modular Robotics System Supporting Creation, Tweaking, and Usage with Mixed-Reality Interactions", Proceedings of the 12th International Conference on Tangible, Embedded, and Embodied Interaction (**TEI 2018**) (**28%** Acceptance Rate)
- C.1** M. Liu, Y. Zhang, J. Bai, Y. Cao, J. M. Alperovich, K. Ramani. "WireFab: Mix-Dimensional Modeling and Fabrication for 3D Mesh Models." Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems. ACM, (**CHI 2018**) (**25%** Acceptance Rate)
- A.3** Y. Cao, Z. Xu, F. Li, W. Zhong, K. Huo, and K. Ramani. "V. Ra: An In-Situ Visual Authoring System for Robot-IoT Task Planning with Augmented Reality." In Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems, p. LBW0151. ACM, 2019.
- A.2** Y. Cao, Z. Xu, T. Glenn, K. Huo, K. Ramani, "Ani-Bot: A Mixed-Reality Modular Robotics System", Adjunct Proceedings of the 31th Annual Symposium on User Interface Software and Technology , 119-121, 2017.
- A.1** Y. Cao, et al., and L. Zhu, "Development of a Microfluidic Gas Generator From an Efficient Film-based Microfabrication Method". 18th International Conference on Miniaturized Systems for Chemistry and Life Sciences, MicroTAS 2014.
- J.1** Y. Cao, Jacob Bontrager-Singer, and Likun Zhu. "A 3D microfluidic device fabrication method using thermopress bonding with multiple layers of polystyrene film". Journal of Micromechanics and Microengineering 25.6 (2015): 065005.
- T.1** Y. Cao, "The development of polystyrene based microfluidic gas generation system". Indian University - Purdue University Indianapolis, M.S., Thesis, 2015