

Zhehan Qu

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RESEARCH INTERESTS

My research focuses on designing, deploying and evaluating **AI-driven systems for safe Augmented Reality (AR)**. To achieve such goal, I conduct **IRB-approved user studies** to uncover the attention patterns in AR, and build **deep learning models** that leverage **eye tracking** to sense **user attention and cognitive state**, with the goal of creating adaptive AR interfaces that **mitigate safety risks in real-time**. To ensure AR safety on application-level, I also work with large vision models like the Segment Anything Model (SAM) for **robust AR scene understanding**, using **edge computing** to facilitate deployment of such systems.

EDUCATION

Duke University

Ph.D. Candidate, Computer Science

Aug. 2022 – Present
Durham, NC, USA

- **Selected Courses:** Theory & Algorithms of Machine Learning, Causal Analysis, Edge Computing, Computer Networks
- **GPA:** 4.0/4.0
- **Advisor:** Prof. Maria Gorlatova

Shanghai Jiao Tong University

Bachelor, Computer Science and Engineering (IEEE Honor Class)

Sep. 2018 – June 2022
Shanghai, China

- **Selected Courses:** Algorithms, Discrete Math, Programming Language, Data Science, Natural Language Processing
- **GPA:** 3.8/4.3

SELECTED RESEARCH

Modeling Situational Awareness in AR-Guided CPR

Oct. 2024 – Oct. 2025
Duke University

Intelligent Interactive Internet of Things Lab

- Designed and implemented an AR application for **AR-Guided cardiopulmonary resuscitation (CPR)**, along with simulated bleeding and vomiting incidents to evaluate **situational awareness** of CPR providers using AR guidance.
- In a **user study with 30 users**, identified that **slower and shorter saccades** and **longer time fixated on virtual content** were correlated with poor situational awareness, measured by whether the incidents were detected and handled properly.
- Designed a **graph neural network** that represents fixations as nodes and spatial-temporal relationships between fixations as edges, achieving **83% accuracy** in predicting situational awareness based on 7s of eye tracking data.
- Paper accepted to **IEEE ISMAR 2025**, a leading conference in the field of augmented and virtual reality.

Analyzing and Predicting the Distraction Potential of Augmented Reality

July 2023 – Sept. 2025
Duke University

Intelligent Interactive Internet of Things Lab

- Developed a **Sudoku helper** application for **AR** and **VR** to study user attention, incorporating step-by-step guidance and controlled visual distractions.
- Conducted a **comparative user study with 38 users** in AR and VR, revealing through **gaze data analysis** that VR simulations induced a **higher perceptual load** and reduced user focus, while AR increased **cognitive load**, as indicated by **increased fixation duration and decreased fixation rate**.
- Trained **time-series Transformers** on eye tracking data to predict the presence of distractors and assess user attentional control.
- Paper accepted to **IEEE ISMAR 2024**

Federated Learning with Data Augmentation

July 2020 – May 2022

Advanced Network Laboratory

Shanghai Jiao Tong University

- Focused on **statistical heterogeneity in federated learning (FL)**, aiming to alleviate the problem of **non-IID data**
- Added a data augmentation stage during global training of FL to complement lacking labels on each client to stabilize distribution of data selected each round; locally fine-tune the model before testing on clients

Readability Controlled Open-Domain Question-Answering System on COVID-19

AI+X Project-Based Learning, NLP Program

Feb. 2021 – May 2021

MIT & Touch EdTech

- Built an open-domain **question-answering** (QA) system based on RAG structure, which enables control of the readability of the answer
- Prepended readability scores to sentences to fine-tune BART, the generator part of RAG, following the CTRL manner; modified the retriever of RAG by adding a score of readability match in addition to similarity check

Internship

Gematria Technologies

Intern (Remote)

Sept. 2021 – Jan. 2022

London, U.K.

- Worked on processing news articles with various tools related to **Natural Language Processing**, including named entity recognition (NER), co-reference resolution, entity linking and sentiment analysis. The work aimed at discovering the sentiment of a given topic in news reports in a certain time period, and further exploiting the information for predicting trends in the stock market

HONORS

Best Doctoral Consortium Presentation Honorable Mention
NSF AI Spring School Applied AI Poster Award

Oct. 2024

Mar. 2024

SKILLS

Programming: Python, C#, C++, R

Machine Learning & Deep Learning: TensorFlow, Keras, Scikit-Learn, PyTorch, Hugging Face Transformers

Tools & Frameworks: Unity (MRTK, Magic Leap SDK), Vuforia, Pandas, Pingouin, pymer4, lme4 (R)

Publications

Conference Proceedings

- [VRST25] S. Baek, **Z. Qu**, M. Gorlatova, AR-TMT: Investigating the Role of Distraction Type and Attention Control in AR Visual Search. To be presented at ACM VRST, Nov. 2025. Code: <https://github.com/Duke-I3T-Lab/AR-TMT>
- [ISMAR25a] **Z. Qu**, T. Hu, C. Fronk, M. Gorlatova, Will You Be Aware? Eye Tracking-Based Modeling of Situational Awareness in Augmented Reality. To be presented at IEEE ISMAR, Oct. 2025.
Video demo: https://www.youtube.com/watch?v=wGF_hvBP-hg; Code: https://github.com/Duke-I3T-Lab/AR_CPR_SA
- [ISMAR25b] T. Hu, T. Du, **Z. Qu**, M. Gorlatova, Spatial Sensing Evaluation for Multiple XR Devices. To be presented at IEEE ISMAR, Oct. 2025. Code: https://github.com/Duke-I3T-Lab/XR_Tracking_Evaluation
- [ISMAR24] **Z. Qu**, R. Byrne, and M. Gorlatova, “Looking” into Attention Patterns in Extended Reality: An Eye Tracking-Based Study. In Proc. IEEE ISMAR, Oct. 2024.
Video demo: <https://www.youtube.com/watch?v=KJo9mlpy4hQ>; Code: https://github.com/Duke-I3T-Lab/XR_Attention_Sudoku
- [IPSN24] L. Duan, Y. Chen, **Z. Qu**, M. McGrath, E. Ehmke, M. Gorlatova, BiGuide: A Bi-Level Data Acquisition Guidance for Object Detection on Mobile Devices. In Proc. ACM/IEEE IPSN, May 2024. (**21.5% acceptance rate**).
IEEE/ACM IPSN Best Research Artifact Runner-up Award. Code: <https://github.com/BiGuideCollection/BiGuide>

Workshop Proceedings

- [IEEEVRW24] S. Eom, T. Ma, N. Vutakuri, A. Du, **Z. Qu**, J. Jackson, M. Gorlatova, Did You Do Well? Real-Time Personalized Feedback on Catheter Placement in Augmented Reality-Assisted Neurosurgical Training. In Proc. IEEE VR Abstracts and Workshops, Mar. 2024.
- [ISMARDC24] **Z. Qu**, Doctoral Consortium: Attention-Safe Augmented Reality System with Edge Computing. In Proc. IEEE ISMAR-Adjunct, Oct. 2024. **Best Doctoral Consortium Presentation Honorable Mention**.

Conference Demonstrations and Poster Presentations

- [XRSecurity25] **Z. Qu**, T. Hu, M. Gorlatova, Demo: More Than Just Compressions: Attentional Tunneling in Augmented Reality-Guided Cardiopulmonary Resuscitation. To be presented at the First Workshop on Enhancing Security, Privacy, and Trust in Extended Reality (XR) Systems, Oct. 2025.
Video: <https://www.youtube.com/watch?v=2MfYJF6sW8A>
- [IEEEVRW24] R. Byrne, **Z. Qu**, C. Fronk, S. Eom, T. Scargill, M. Gorlatova, AR Simulations in VR: The Case for Environmental Awareness. In Proc. IEEE VR Abstracts and Workshops, Mar. 2024.