# AUGMENTED AND VIRTUAL REALITY PH.D. TRAINING PROGRAM AT THE UNIVERSITY OF ROCHESTER

Program Overview

This NSF Research Traineeship (NRT) Program is an interdisciplinary PhD training program in the science, technology, and applications of Augmented and Virtual Reality (AR/VR).

Our Mission & Vision

- Train a new cohort of PhD students with a unique set of competencies in the AR/VR domain that cannot be attained through existing traditional graduate programs.
- Advance interdisciplinary research with an innovative theme: integration of quantitative models of human perceptual-cognitive processes into cross-layer design approaches to create and quantitatively evaluate new AR/VR technologies and applications.
- Integrate AR/VR research throughout the campus into our program through trainee projects and theses.
- Use evidence-based strategies for inclusive participation.
- Develop technical and professional skills of the trainees.
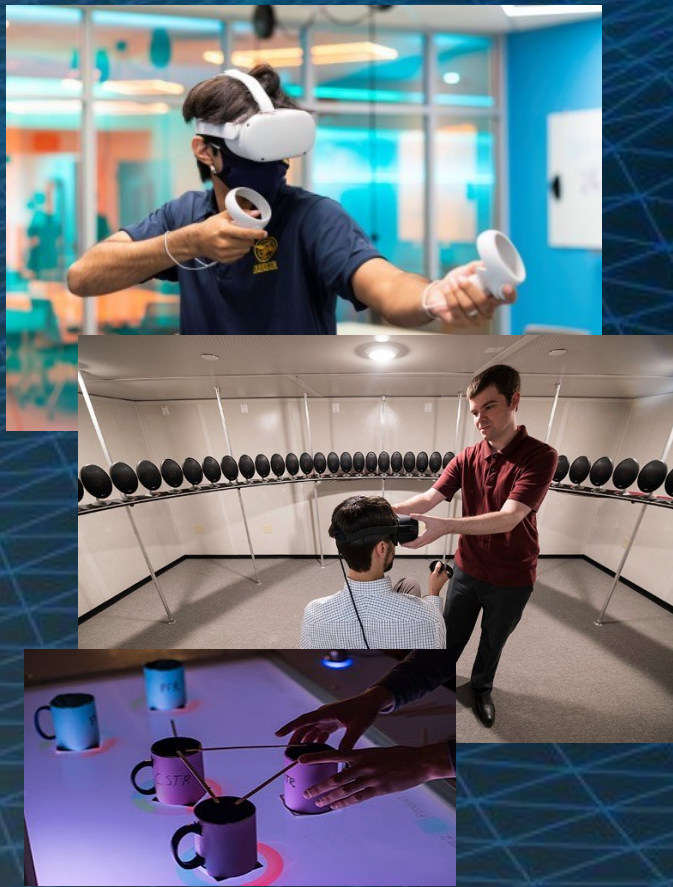
Education & Training

The training program admits PhD students from six departments representing the disciplines encompassed by AR/VR:
1. Electrical and Computer Eng.
2. Optics
3. Biomedical Eng.
4. Brain and Cognitive Sciences
5. Computer Science
6. Neuroscience

The program also offers one-year funded fellowships to a limited number of trainees.

The program involves three innovative courses and other training elements as listed below.

Semester/ Year in Ph.D.	Training Element
Fall/1	Introductory course
Spring/1	Modular course
Summer/1	Unity Programming Course and Practice
Fall/2	Practicum course
Summer/2	Internship
All Years	Professional development encounters
2-5	Annual Program showcase and student-run conference
3-4	Undergraduate capstone project supervision
All Years	AR/VR-related research

Introductory Course on AR/VR

This course provides a broad introduction to AR/VR, is cross-listed by seven departments at the University, and taught by 10 instructors.

Goals

- Build a common base of understanding and knowledge for all trainees in the program as well as provide a foundation on which they can build their research.
- Benefit trainees with diverse backgrounds.

## Structure

Two parallel components:
1. Lectures providing introduction and awareness on all aspects of the AR/VR domain.
2. An individualized, guided self-study component for each student aimed at providing more intensive training on aspects of AR/VR on which the student is less knowledgeable.

- Lectures cover aspects of AR/VR including: history, platforms/hardware, computation and coding, graphics and displays, perceptual/cognitive aspects, sensors, data processing and machine intelligence for AR/VR, visual/auditory/haptic AR/VR interfaces and applications, as well as current challenges, societal implications, and ethical aspects.
- A coherent course rather than a collection of independent lectures.
- Course is designed and taught multiple faculty with expertise on different aspects of AR/VR.
- Each student determines a self-study theme with the guidance of the coordinating faculty.

Overall Courses Designed to...

1. Expose the students to aspects of the domain they are less familiar with.
2. Open discussion session on what has been learned through these independent efforts.

Modular Course

- Three one-month modules in each offering.
- Modules offered:
1. Fundamentals of optics for AR/VR
2. AR/VR in the silicon
3. Foundations of visual perception in the context of AR/VR
4. Computer audition and acoustic rendering
5. Measuring the human brain
6. Deep learning and visual recognition for AR/VR
7. Brain-computer interfacing in a virtual environment
8. 3D interfaces and interaction
9. AR/VR for collaborative education & professional training
- In conjunction with modular course taught, students attend a series of seminars given by AR/VR leaders from industry and academia. Focused in-depth exposure to problems in the AR/VR domain addressed by the other disciplines.

NRT COURSEWORK

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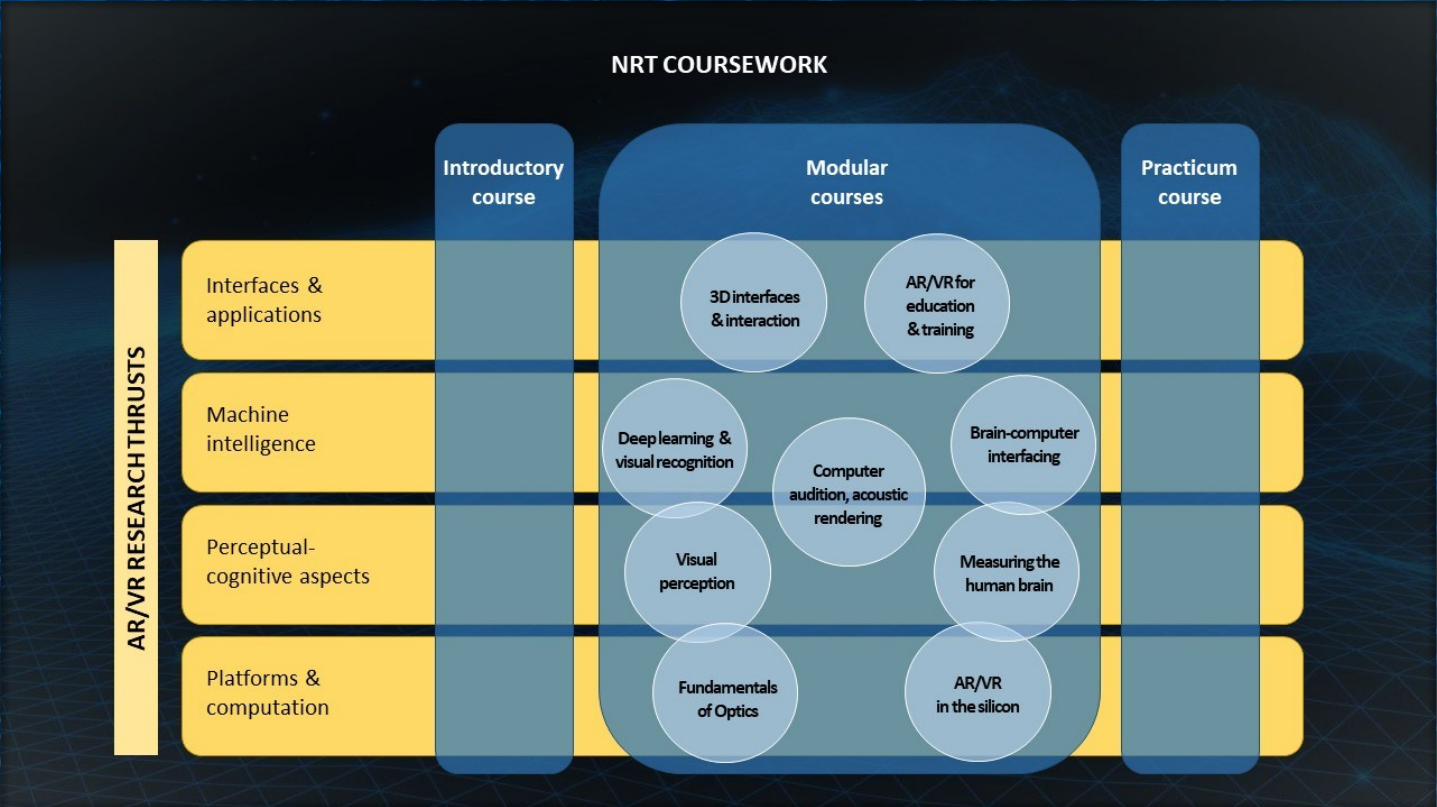
Industry-Sponsored Fellowships

Students in this program also have opportunities to engage with companies through fellowships given by the company. We would require a 1-3 year commitment from the company to sponsor a student. It is the goal of some of the companies and our program to offer Diversity Fellowships to less advantaged students of color and women especially.

Our Industry Partners Include:

facebook
Reality Labs

Microsoft

NVIDIA.

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NRT PhD Trainees—Cohort starting in 2020-2021

Frank Cwitkowitz — Dept. of Electrical & Computer Engineering. **Research Interests:** Music information retrieval, music signal processing, machine learning, and solving problem of automatic music transcription

Jeremy Goodsell — Institute of Optics. **Research Interests:** studying the application of freeform surfaces and meta-gratings to the field of augmented and virtual reality (AR/VR).

Narges Mohammadi — Dept. of Electrical & Computer Engineering (Data and Imaging Science Lab). **Research Interests:** Computational imaging, low-level computer vision, optimization, and statistical signal processing tools for AI.

Eleni Patelaki — Biomedical Engineering. **Research Interests:** Solving problem of Parkinson's disease risk by systematically loading cognitive and motoric neural circuits, utilizing the Mobile Brain-Body Imaging modality.

Shadi Sartipi — Dept. of Electrical & Computer Engineering. **Research Interests:** VR/AR, brain-computer interfaces (BCIs), statistical and biomedical signal processing, affective computing, and machine learning.

Yuxiang Wang — Dept. of Electrical & Computer Engineering. **Research Interests:** Spatial audio, HRTF and auditory models.

You (Neil) Zhang — Dept. of Electrical & Computer Engineering (Audio Information Research "AIR" Lab) **Research Interests:** Machine learning and its applications in speech processing, such as voice spoofing detection, audio-visual understanding, and spatial audio.

NRT PhD Trainees—Cohort starting in 2021-2022

Meiying Chen — Dept. of Electrical & Computer Engineering. **Research Interests:** Machine Learning with Zhiyao Duan. Universal vocoders: In text-to-speech synthesis, vocoders are used to convert intermediate representations (e.g. Mel-spectrograms) to the waveform.

Jin Dou — Dept. of Biomedical Engineering. **Research Interests:** Decoding and encoding the human brain signals.

Erin Driscoll — Dept. of Electrical & Computer Engineering. **Research Interests:** Applying optical wavefield coherence theory to problems in acoustics and audio signal processing.

NRT PhD Trainees—Cohort starting in 2021-2022 (cont.)

Yiwen Fan — Institute of Optics. **Research Interests:** Focus on interdisciplinary research related to AR/VR. Specifically, investigation of the architecture of optical system designs, leveraging not only freeform optics and metasurfaces (two emerging technologies) but investigating a unique technology patented in University of Rochester's Metaform Lab.

Ali Vosoughi — Dept. of Electrical & Computer Engineering. **Research Interests:** Machine vision, especially a new generation of causal machine vision.

Qinqin Xiao — Warner School of Education. **Research Interests:** Developing the HAR2bot in the real application for engineers, medicine students, clinic interns, doctors, etc.

Pei Xiong — Institute of Optics. **Research Interests:** Intersection of optical physics and optical engineering, with focus on how metasurfaces (a state-of-the-art nanophotonic device) can enable new approaches to waveguide-based AR/VR geometries.

Erqian Xu — Warner School of Education. **Research Interests:** Leverage AR/VR technologies and empower artist-technologists, along with their potential audience with or without developmental disabilities.

Xiaofei Zhou — Dept. of Computer Science. **Research Interests:** Novel machine learning visual analytics, and novel data interaction.

Eli Mercer — Dept. of Electrical & Computer Engineering. **Research Interests:** 3D audio sound source localization using audio filtered with head related transfer functions. Digital and audio signaling. *(On sabbatical until May, 2023)*

NRT PhD Trainees—Cohort starting in 2022-2023

Matt Ferguson — Institute of Optics. **Research Interest:** Application of freeform optics and metasurfaces to AR/VR optical systems.

Yunfan Gong — Warner School of Education. **Research Interest:** Design and implementation of social and tactile augmented reality to support undergraduate STEM learning and K-12 after-school science clubs. Research project that studies practicing and pre-service science teachers' justice-centered ambitious science teaching practices.

Beilei Guo — Warner School of Education. **Research interest:** Participation in an NSF funded project "Motivation in Science among Students with Learning Disabilities" were researchers investigate the role of motivational beliefs in predicting and supporting participation, persistence, and success of students with learning disabilities in science coursework and careers.

Paul Jolly — Dept. of Brain & Cognitive Sciences. **Research interest:** Developing a head-mounted version of the digital dual-Purkinje image eye-tracker. With this high-precision device, he plans to study how eye movements shape the visual input signals to the retina during natural head-free tasks.

Chi Zhang — Institute for Optics. **Research Interest:** Study of afocal zoom system designs using freeform optics.

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