Interdisciplinary Graduate Training in the Science, Technology, and Applications of Augmented and Virtual Reality

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We present the rationale, structure, and components of a new Ph.D. training program on augmented and virtual reality (AR/VR) at the University of Rochester, funded by the National Science Foundation (NSF).

AR/VR promises to become one of the most disruptive technologies of the 21st century, revolutionizing how we interact with each other, with our environment, and with devices and systems. VR uses advanced display and immersive audio technologies to create an interactive, three-dimensional (3D) environment. AR uses digital technology to overlay virtual objects onto the physical world to provide information and embellish our experiences. Current and envisioned application areas include health care, education, professional training, architectural and product design, remote interaction, and entertainment. Continued progress in the burgeoning field of AR/VR requires researchers with multi-disciplinary Ph.D. training and research experience spanning multiple disciplines including electronic and computing systems, perceptual and cognitive neuroscience, optics and imaging, computer vision, acoustics and audio, and human-computer interfaces. To address this need and realize the transformative potential of AR/VR technologies, this National Science Foundation Research Traineeship (NRT) Award to the University of Rochester will facilitate the development of a structured, multi-disciplinary Ph.D. training program on AR/VR. The project anticipates training 62 Ph.D. students, including 12 funded trainees, from Electrical and Computer Engineering, Optics, Biomedical Engineering, Brain and Cognitive Sciences, Computer Science, and Neuroscience. In addition, the project will benefit approximately 300 other STEM graduate students who will participate in aspects of the training and professional development. Trainees will gain the vision and skills to advance AR/VR technologies as well as an appreciation for the broader cultural and societal implications of these technologies. The project will train inclusive cohorts of scientists and engineers to contribute to society as technical leaders in industry, academia, and government.

The project will train a new cohort of Ph.D. students with a unique set of competencies in the AR/VR domain. It will help shape how future scientists and engineers will be trained not only in AR/VR but more broadly in human-data-system interfaces. The project will 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. Research thrusts integrated with the training program in a cross-cutting manner will advance the scientific foundations of AR/VR systems and impact the design of next-generation AR/VR systems. These research thrusts, corresponding to four layers of the AR/VR problem domain, are: (1) AR/VR platforms and computation, (2) perceptual-cognitive aspects of AR/VR design, (3) machine intelligence for AR/VR systems, and (4) AR/VR interfaces and applications. The training program contains three new innovative courses addressing the diverse backgrounds of incoming trainees, exposing them to AR/VR challenges and providing competency to work on AR/VR projects within multi-disciplinary teams as well as a variety of structured professional development activities. In addition, the training will include industry internships and immersive professional development encounters with industry leaders. Both the graduate training model and its outcomes will be widely disseminated to the broader academic community through organized events and web presence.

**Keywords**—Augmented reality, virtual reality, Ph.D. training, human-computer interfaces, machine intelligence, perceptual and cognitive neuroscience, optics.