Overview

Physical assurance is a crucial aspect within microelectronics fabrication and assurance education, particularly in light of the rapidly expanding global supply chain of electronics. The recent implementation of the CHIPS Act highlights the pressing need to bolster domestic manufacturing and ensure microelectronics assurance. Despite the increasing demands, there is a *nationwide shortage of skilled labor* capable of performing essential physical assurance tasks. The educational challenges in this field are numerous, including limited laboratory facilities due to the extremely high costs, time barriers, and the student's lack of engagement in such inherently complex topics. The *goal* of this project is to investigate and integrate virtual reality (VR) technology to scale up the accessibility and engagement in physical assurance training. VR offers a unique opportunity to personalize the learning experience and effectively engage students through interactive 3D graphics and simulations. This project will design an immersive VR training on microelectronic physical assurance and incorporate gamification components, allowing students to track their own progress. The University of Florida is in an *ideal position* to carry on the proposed project. PI Asadi's SeCurity and AssuraNce (SCAN) lab is one of the top few nationwide labs providing on-site training on physical assurance. Co-PI Kang has extensive expertise in VR interaction design, and Co-PI Moore has extensive experience in evaluating digital learning environments. The VR training will be integrated into an existing course Asadi has developed under prior NSF support. We will examine students' learning outcomes, comparing VR and traditional on-site training. The final VR application will be disseminated to the broader public, including professional trainees such as veterans and technicians.

Intellectual Merit

This project will make novel *contributions* to diverse fields, including human-computer interaction, education technology, and microelectronics assurance research. To the best of our knowledge, the proposed VR MiPA will be the first one of its own kind to investigate the use of VR in physical assurance education and examine its relative impact on students' learning outcomes compared to traditional on-site training. Although a growing body of research explores VR for future workforce training, prior work predominantly focuses on medical training or safety training for high-risk professionals. Relatively little work accessed VR's educational benefits in the domain of electrical engineering and microelectronics assurance. Our access to the SCAN lab and co-PI's existing curriculum on physical assurance provides a unique opportunity to conduct comparative research in the field setting and examine students' learning outcomes with quizzes in addition to conventional surveys. Furthermore, publishing VR applications on the web enable us to carry on *summative evaluation* by collecting users' behavior data (e.g., average playtime, task completion rate, number of software downloads) and examining users' engagement beyond the project period. Together, the proposed research activities will contribute to the *education research knowledge base*, answering critical questions, including virtual teachers' role in the learning experience, the difference between traditional and virtual embodied learning experiences, and experiential learning in STEM education.

Broader Impacts

This project will significantly impact microelectronics assurance education and future workforce development. VR MiPA brings together diverse stakeholders, including students, instructors, and industry partners to ensure the coverage of industry-relevant skills through VR training for future jobs in microelectronics assurance, fabrication, failure analysis, validation, and more. Such multidisciplinary collaboration will contribute to *the new knowledge transfer* between academia and industry. We will make the VR materials available to K-12 students and teachers and *help K-12 teachers* integrate physical assurance into education through multiple programs at UF, including UF Center Pre-collegiate Education and Training and the Florida Youth Institute. Furthermore, the project outcome will also be *shared with the industry* at various technical events, including the International Symposium for Testing and Failure Analysis (ISTFA) and Physical Assurance and Inspection of Electronics (PAINE), which PI Navid organizes as a general chair. The proposed VR training will enhance the *accessibility to STEM education* and educate the next-generation workforce in microelectronics assurance, ultimately helping the nation regain its competitiveness in the global semiconductor market.

Keywords:1.Cybersecurity Education, 2.Intrusion Detection, 3.Social, Behavioral and Economic Sciences.