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Development of a Multiuser Collaborative Virtual Training Environment for Photolithography Cleanroom Processes

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The semiconductor industry relies heavily on photolithography processes conducted in controlled cleanroom environments, where training and collaboration are constrained by stringent contamination protocols, high operational costs, and physical limitations. To address these challenges, we present a novel immersive Collaborative Virtual Training Environment (CVTE) designed for multiuser interaction and collaboration. This system enables participants to engage in shared simulations of cleanroom workflows, fostering real-time teamwork without the risks associated with physical cleanrooms. Key features include synchronized multiuser avatars for interpersonal communication, controller-based interactions for manipulating virtual photolithography equipment (e.g., wafer handling, mask alignment, and exposure simulation), and environmental fidelity. Python scripting facilitates dynamic scenario customization, real-time physics simulations, and the integration of collaborative tools such as shared annotations and voice chat. Preliminary evaluations demonstrate low-latency synchronization across networked head-mounted displays (HMDs), achieving response times under 50ms for interactions, and high user immersion scores via standardized VR questionnaires. Our VTE represents a scalable solution for industrial training on semiconductor device fabrication, with potential extensions to other high-stakes manufacturing domains. Future work will incorporate haptic feedback and AI-driven adaptive scenarios to further elevate collaborative efficacy.

Academic or Professional Status

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