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Augmented Reality Tools for Teaching Quantum Mechanics

Abstract

Quantum mechanics presents unique pedagogical challenges due to its highly abstract and counterintuitive nature. Concepts such as wave–particle duality, superposition, entanglement, and the probabilistic interpretation of the wave function are difficult to convey through traditional lectures, textbooks, or static visualizations. As a result, many students struggle to develop robust mental models of quantum phenomena.

This talk presents the design, development, and classroom implementation of augmented reality (AR) applications created specifically to support the teaching and learning of quantum mechanics at the undergraduate level. By overlaying interactive three-dimensional visualizations onto the real world, these AR tools allow students to manipulate quantum states, explore probability densities, and observe the consequences of measurement in an intuitive, spatially grounded manner. Key modules address the double-slit experiment, the time-dependent Schrödinger equation for simple potentials, spin systems, and basic two-qubit entanglement.

We discuss the educational design principles underlying the apps, the technical framework used for their development, and preliminary results from classroom trials assessing student engagement, conceptual understanding, and self-reported confidence. The talk concludes with reflections on the opportunities and limitations of AR as a complementary tool in quantum education, and outlines directions for future refinement and broader adoption.