Mixed Reality Chemistry Lab for the Meta Quest 3

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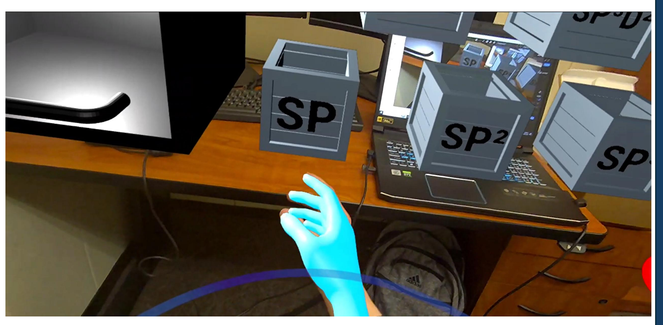
Objective

Mixed Reality (MR) bridges the gap between the digital and physical world, offering immersive interactions in various fields, including education. The Meta Quest 3's advanced spatial computing features allow for new interaction paradigms that enhance learners' engagement. This applied research project aims to develop and implement an MR Chemistry Lab that helps students understand and visualize orbital hybridization better.

Method

1. Development Environment: Built using Unreal Engine 5.4 with the Oculus XR Plugin to leverage Meta Quest 3's MR capabilities.
2. Interaction Design: Implemented hand tracking, spatial mapping, and precise MR asset positioning in physical space to enhance spatial awareness and interaction.
3. Usability Testing: Conducted user trials to evaluate interaction speed, accuracy, and ease of use.

Results



•Development resulted in implementing a successful prototype that simulates orbital hybridization correctly.
•Hand tracking and hand gestures eliminated the need to use unintuitive controllers and mechanics, especially for first-time MR users.
•Audiovisual elements were implemented to help guide students to complete the simulation by receiving real-time feedback about their interaction.

This project aims to implement a **Mixed Reality** Chemistry Lab to help students learn and visualize the process of **orbital hybridization**.

Discussions

This project demonstrates the potential of Mixed Reality for enhancing student learning in class. By integrating real-time spatial mapping and intuitive hand tracking, MR applications can enhance student engagement. However, challenges remain in optimizing tracking accuracy and reducing occlusion errors in complex environments.

Experience Overview: This project presents an interactive Mixed Reality molecular orbital hybridization simulator for the Meta Quest 3. Players manipulate s, p, and d orbitals in a virtual space, combining them to form hybrid orbitals like sp, sp^2, sp^3, sp^3d, and sp^3d^2. The experience includes an energy calibration system, where students must adjust the correct amount of energy to successfully hybridize orbitals. If the energy input is too high or too low, the combination fails, reinforcing real-world chemistry principles. By using hand tracking and spatial awareness, the experience provides an engaging, hands-on learning experience, making abstract quantum chemistry concepts more tangible and interactive.

Future Work

The next step is to conduct classroom studies to evaluate the impact of this MR experience on actual learning outcomes. This includes:
1. Comparing student performance using MR vs. traditional teaching tools.
2. Gathering qualitative feedback on user experience and engagement.
3. Iterating on the interface based on classroom trials and feedback.

Remarks

This was a collaboration between the chemistry and computer science departments to make a mixed reality game for chemistry students.

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