Exploring natural user interface for STEM learning in mixed reality environment

Outline:
The recent emergence of computer vision and graphics technologies has raised interest in exploring how immersive mixed-reality environment advances STEM(Science, Technology, Engineering, and Mathematics) education[2]. As mixed-reality merges the real world with digital virtuality[1][3], the environment have proved its strong potential to engage learners in immersive experience and enhance pedagogy in STEM disciplines which generally requires in-depth understanding of scientific theories and phenomena. However, from user experience perspectives, the pedagogical affordance and impact of user interface has not been well explored while numerous AR(Augmented Reality) or VR(Virtual Reality) applications confirmed the efficacy of visual and acoustic immersion. Our proposed work starts with identifying the key characteristics of the natural user interfaces that involves the actions of body and following embodied cognition in learning contexts. This will allow us to establish design criteria that should be especially deeply considered or avoided. Then we design and develop user interfaces that are more suitable for a set of specific STEM learning disciplines by extending or tweaking existing interfaces based on the previous findings. Finally, we evaluate the prototypes from both technical and pedagogical domains, harnessing our research partnership with local educational organizations

Intellectual Merit:
- Interdisciplinary research that spans computer science and education
- Advancing application-specific natural user interfaces in MR contexts
- Envisioning user experience designs for STEM learning

Broader Impact:
- Induce children to seek advanced learning opportunities in STEM disciplines by getting children excited and engaged in learning experience
- The nation needs to motivate young students into STEM fields so as to maintain global leadership and competitive position
- Improving collaboration skills of students
- Promotion of reflection in children and stimulating their awareness.
- After the setup, modifying and controlling the situations is easier and less costly than in a real-world environment

Time, Costs and Risks:
The project faces several theoretical and technical challenges. First of all, we need to investigate as many related user interfaces as possible to obtain and analyze the advantages and disadvantages of the existing interfaces. After we propose a new theory for the interfaces, we need to build an interface combining all features together with as little storage space and as much efficiency and effectiveness as possible, which entails significant technical challenges. We estimate that this project will take about two years and require a budget of 250k per year. This project will be conducted by three PhD students and one post-doc with high competence and passion in the field of data visualization, database and software engineering. The proposed budget will be primarily used to pay the tuition and salary of PhD students and the salary of the post-doc. Additionally, in order to complete this project, new equipment and licenses for appropriate software techniques are needed to be purchased.

Reference