Motion Controls for a Natural User Interface in a Virtual Learning Environment

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***Abstract*—With the ever-advancing technology, the idea of a virtual learning environment is becoming more normalized. Virtual classrooms are becoming more standardized and are being used more frequently. Currently, these virtual classrooms lack full immersion partially from the lack of motion controls to create a natural user interface. The end goal is to have students be able to interact and feel as if they are immersed in the classroom so learning becomes the priority. The integration of motion controls will help to create a more engaging learning environment, as students can have a more direct and interactive experience with their learning material. We are aiming to create a mock-up of a virtual classroom that utilizes hand-raising and head-shaking gestures from the students. We want to create a more physically and mentally engaging classroom in Virtual Reality (VR) for the student. These features will also help the teacher monitor class engagement and get live reactions. With the level of immersion increasing, students will enter a learning environment in which they can be more involved with their studies, increasing engagement and surpassing learning goals.**

***Index Terms*—Motion Controls, VR Integration, Virtual Classroom, Natural User Interface, Gesture Tracking**

I. Introduction

When looking into the future of virtual learning a natural next step from screen-based instruction is to add a dimension and utilize virtual reality to increase immersion. Reference [1] shows the effects of virtual reality in the teaching and learning environment have had positive effects on both the achievement and engagement of students. Simple and effective ways to teach in more interactive ways are becoming more readily available to the public, with things like a focus on webcams and projectors [2]. Motion tracking in a virtual classroom setting has some prior research implications. In [3] research revolved around the Microsoft Kinect Sensor to improve human-computer interaction. Using the Kinect is a simple way to work with gesture-based interactions. They suggested the creation of simple actions to aid the user's experience. Building on that suggestion, a Kinect sensor was used to keep the professor engaged with the online students [4]. After calibrating the users, the sensor would detect bodies and look to see if a user's hand was raised. If it was the professor's screen it would highlight that student's name and zoom in on them (**Fig. 1**). Allowing the professor to teach and still let the students interact in the virtual classroom. Usability is also key to the research we are trying to look into, the effects that VR can have on users with Attention-deficit/hyperactivity disorder (ADHD) and anxiety are discussed. Various virtual tasks we designed to measure which virtual tasks if any kept students engaged and productive [5]. It seemed promising that simple tasks in the virtual classroom would be enough to keep the student more engaged. All of these factors culminate in creating an engaging and surprisingly physical learning environment for students. This compiled research will aid in the development of VR software that will create new opportunities for students in all different educational environments.

II. Methods

One of the first things we established was a leadership plan for the project semester. We wanted to lay out a guideline and create a strong plan for how to play to our strengths and tackle this project. We opted to utilize Trey's flexibility and creativity to start the initial half of the semester where iteration and the design thinking process are key parts. Then we can narrow down our view and use Roy

Methods that have been approached in literary review research include conducting studies on multiple control groups, allowing for comparisons between different learning environments (**Fig. 2**). After completing a preemptive test to observe knowledge on a given science lesson, all ninety sixth-grade students were split into two groups with one focusing on Immersive Virtual Reality (IVR), and the other group having traditional teaching methods. The IVR group of students reported higher achievement and engagement scores in the four main categories they were researching; cognitive, behavioural, emotional, and social [1].

In [2] the creation of the Physical Interactive Learning Environment (PILE) helped young Taiwanese students learn English. The PILE program was created with minimal equipment such as a laptop, webcam, and a projector. This is opposed to testing more expensive VR options. After the students completed 6 stages of tasks and learning goals, all finding point towards the PILE system aiding in the learning of English in classrooms.

Kinect has the potential to open up new learning in areas such as human-computer interaction (HCI), human factors,s accessibility, emerging technology, and the development of effective interfaces [3]. Additionally using Kinect for gesture-based interactions has beneficial software such as Open Natural Interaction (OpenNI). These Kinect-assisted learning activities can be easily taught and educated with a small amount of C, the programming language.

When researching gesture recognition, the Kinect is again mentioned. Using simple code, the program can sense users, display the students name, and identify the raising and lowering of hands. Accessibility in HCI is also very important to the gesture recognition technology, meaning that Kinect and similar options can help physically challenged users interact with computers [4].

Virtual environments can simulate and enhance modern classrooms using VR technology. Classrooms can become multi-purpose sites to teach more hands-on content such as rehabilitation scenarios, training, assessment and diagnosis. Some of the mentioned applications already in development are: eye tracking for children with ADHD, earthquake safety maps designed to lead students out, and anxiety assessment and graduated exposure therapy for children with Social Anxiety Disorder. Virtual Classroom's user-centered design evaluation phase consisted of twenty non-diagnosed children from ages 6-12, tried various evolving forms of the system over the first year of development and their performance was observed while trying out a variety of basic selective and alternating attention tasks [5].

Using all this research we are able to compound the data and begin working on our own project. In order to keep our project and results on time we created a Gantt chart. Our goal was to set time goals for each of our projects and highlight the management for those tasks. Having Trey in the leadership position for the first two projects due to his flexibility and creativity. In terms of the rest of the semester, Roy will be taking charge. His strengths include focusing on and refining a concept since he is very analytical. We also feel he will be able to make the hard decisions of the necessary design cuts if needed. View the appendices for our compressed Gantt chart, along with our GitHub link to a downloadable full-scale version (**Fig. 3**).

III. Results

The identified gap in the literature review is that there are lapses in immersion and engagement due to most of the current technology being webcam-based. The current webcam technology allows for very limited student interaction which creates a poor environment for students to engage while learning. We believe that utilizing a VR environment will not only be more immersive but it allows the opportunity to design more engaging tasks and interactions for the students.

Our design thinking process consisted of 5 major stages. We started with the core idea of making the virtual classroom more natural. From there we started the empathizing process. We read and utilized our research papers to see what the current field looks like and what adaptations are being made. We discovered that there was a serious lack of realistic controls that utilized the user's gestures. Immersion is a big part of the virtual classroom and a large area of immersion is missing without proper controls set in place. We also saw a lack of improvement in the virtual reality classroom. This led to our next stage of concluding that the problem we wanted to tackle was designing a natural user interface that utilizes the functionality of motion controls to better immerse the students.

In the ideation process, we came up with some concepts to allow VR learning to become more of a common practice. With our problem in mind, we each brainstormed 10 ideas that could aim to create a better immersive experience for the students using motion controls. We settled around the idea of a hand raise gesture and being able to display your answer to a simple question.

In terms of our prototype, we have a few ideas that we want to portray. Our plan is to develop a mock-up classroom in a virtual reality unity scene. It will be stationary and have the student sitting at their desk. One of the core features is when the student raises their hand their microphone is activated. Another feature is our Yes and No question displays. When prompted by the teacher the student can shake their head 'yes' or 'no' and a corresponding check or an 'X' mark will be displayed above their head. This will allow teachers to monitor class participation and keep the students physically and mentally engaged.

IV. Conclusion

When it comes to keeping students physically and mentally engaged in the virtual learning environment, incorporating the user's motion controls is key. In current Kinect sensor-based solutions, gesture-based controls not only allow for more student engagement but it helped the teacher keep track of the class. The problem with that environment is that students are not fully immersed in the virtual classroom. We wanted to find a way to keep student engagement high while furthering their immersion, creating an optimal learning experience. Our solution to transition these motion-controlled gestures to a VR setting allows for the students to be fully engaged with their actions and immersed at the same time. Our design creates a better way for the teachers to be able to see classroom engagement while teaching in the VR environment. Throughout the semester we plan to optimize and provide a base prototype that can show off the core functionality of our design. After our project, we hope to inspire others to use our findings and further the full development.

References

[1] R. Liu, L. Wang, J. Lei, Q. Wang, and Y. Ren, "Effects of an immersive virtual reality-based classroom on students' learning performance in science lessons," British Journal of Educational Technology, vol. 51, no. 6, pp. 2034–2049, 2020.

[2] B. Hariharan, S. Padmini, and U. Gopalakrishnan, "Gesture recognition using Kinect in a virtual classroom environment," 2014 Fourth International Conference on Digital Information and Communication Technology and its Applications (DICTAP), 2014.

[3] N. Villaroman, D. Rowe, and B. Swan, "Teaching natural user interaction using openni and the Microsoft Kinect sensor," Proceedings of the 2011 conference on Information technology education, 2011.

[4] J. C. Yang, C. H. Chen, and M. Chang Jeng, "Integrating video-capture virtual reality technology into a physically interactive learning environment for English learning," Computers & Education, vol. 55, no. 3, pp. 1346–1356, Nov. 2010.

[5] A. A. Rizzo, T. Bowerly, J. G. Buckwalter, D. Klimchuk, R. Mitura, and T. D. Parsons, "A virtual reality scenario for all seasons:the virtual classroom," CNS Spectrums, vol. 11, no. 1, pp. 35–44, 2009.

V. Appendices

GitHub Link: https://github.com/RoyWales/EmergingTechnologies

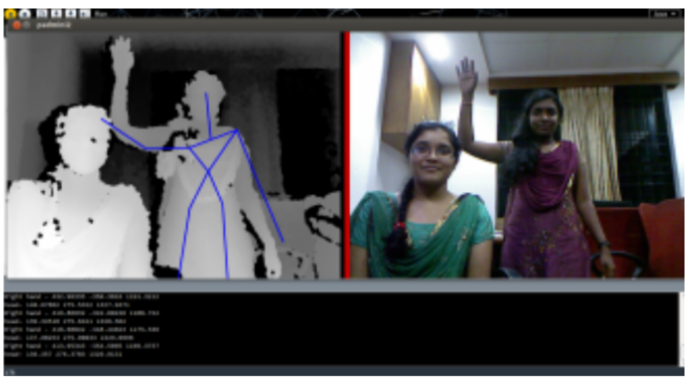
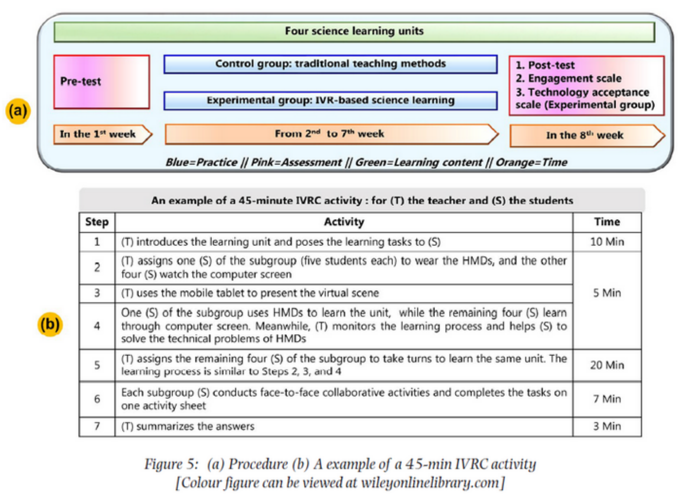


Fig. 1. Kinect Gesture Tracking. Adapted from [2]



An example of a 45-minute IVRC activity : for (T) the teacher and (S) the students

Step	Activity	Time
1	(T) introduces the learning unit and poses the learning tasks to (S)	10 Min
2	(T) assigns one (S) of the subgroup (five students each) to wear the HMDs, and the other four (S) watch the computer screen	
3	(T) uses the mobile tablet to present the virtual scene	5 Min
4	One (S) of the subgroup uses HMDs to learn the unit, while the remaining four (S) learn through computer screen. Meanwhile, (T) monitors the learning process and helps (S) to solve the technical problems of HMDs	
5	(T) assigns the remaining four (S) of the subgroup to take turns to learn the same unit. The learning process is similar to Steps 2, 3, and 4	20 Min
6	Each subgroup (S) conducts face-to-face collaborative activities and completes the tasks on one activity sheet	7 Min
7	(T) summarizes the answers	3 Min

Figure 5: (a) Procedure (b) A example of a 45-min IVRC activity [Colour figure can be viewed at wileyonlinelibrary.com]

Fig. 2. Science Class Plan. Adapted from [1]

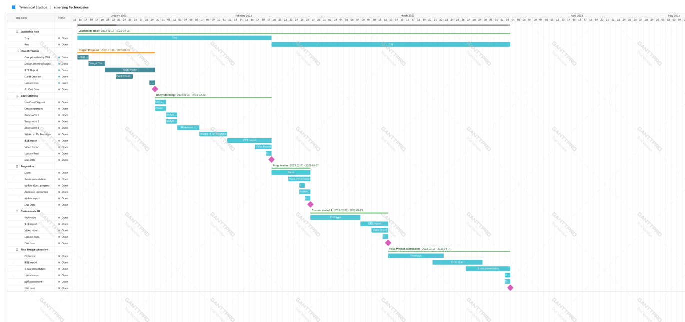


Fig. 3. Gantt Chart

Fig. 4. Vitual Reality Classroom. Adapted from [5]