Enhancing virtual classroom interaction with 3D user interfaces

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ABSTRACT

This document shows a virtual classroom platform design for synchronous e-Learning based on 3D user interfaces. The platform, named *Teacher Assistant* (TA), is intended to give all the tools necessary to manage a whole class without any device. Like this, the teacher is able to give a whole class without any interruption and with freedom of movement. We use the Microsoft Kinect as an interaction tool, this way the user controls the application with his own body. Although the development of some components of TA is in process, this platform shows a new way of interaction between students and teacher.

Keywords: Virtual Classroom, virtual education, teaching environment, Microsoft Kinect, synchronous e-Learning.

1 INTRODUCTION AND MOTIVATION

Nowadays, distant learning is an effective alternative to access superior education for almost any person. Virtual courses has many facilities to overtake some constraints like living in a different country, physical impairment or economic difficulties; however, current virtual platforms (applications to support virtual classes) lacks some of the characteristics that are helpful in a real classroom [1]. This is why recent works in the existing literature make an effort to try to simulate the natural classroom characteristics in a virtual environment [1, 2, 3]. For example, giving the student the possibility to have face-to-face interaction with the instructor and other students is a helpful and motivating characteristic for both pedagogy and andragogy. Taking this into account, the advances in technology can help improving the possibilities of having a successful learning in an online environment.

The teacher is a guide in the course of the class, so he needs to prepare activities (presentations, discussions, exams, etc.) that maintain the interest of the student, solve their doubts and evaluate their progress. In a virtual classroom environment, the teacher capabilities are constrained to the tools that are available in the platform and the ease of use of each one of them. To offer to the teacher the appropriate components in the virtual classroom design, we took into account these features [3]:

Interactivity:
The interaction of the student with the instructor and other students is very important for online learning.
Synchrony:
The relevance of synchronous or asynchronous communication depends on the nature of each activity. Some authors around the existing literature concluded that asynchronous instruction is more favorable in terms of student outcomes, but synchronous is more favorable for motivating the student to participate [3, 4]. Synchronous communication is also useful to have a feedback of the emotional state of the students [5].
Usefulness and ease of use:
Teacher will not use components that are not useful or that are difficult to handle.
Sense of community:
If the student feels like a part of a community, he will be more motivated to go ahead with the course over the natural difficulties that can appear in a class.

TA was designed to give the user all the tools he needs in a simple interface. The teacher should be able to do changes in the class settings in a few seconds; without disturbing the class fluency and saving time (i.e. publishing content or organizing discussion groups). Using this platform, the teacher will be able to communicate effectively with his students, being always aware of their emotional state. Furthermore, a 3D user interface gives to the teacher freedom of movement and the possibility to access to the application at any moment with his body. The design of TA takes into account the most important features of a virtual classroom and proposes a new way of interaction using the body as a control.

2 RELATED WORK

Virtual classrooms have being studied from different points of view. More than that, all the studies are focused on finding critical aspects of these classrooms that can improve the student performance on the courses. [1] and [3] studies a wide benchmark of existing platforms for online learning and analyses the importance of each component they expose and the perception that the students have of each interaction method. [6] proposes an architecture for a real-time interactive virtual classroom; most of the features of this work are based on the architecture presented here. [1], [4] and [7] studies the different teaching models (knowledge presentation and problem base learning) and compares the behavior of each one in a virtual with a real classroom. Finally, [8] show important aspects of virtual classrooms that make them different to a real classroom and that must be taken into account when you are teaching a distant course.

3 TEACHER ASSISTANT DESIGN

The design of TA is compound by three main components (see Figure 1): Content manager, presentation control and student awareness. The components should be arranged in a two screen layout with the student awareness component on the right screen such that the teacher is always conscious of the emotional state of all the students. The content manager and the presentation control will occupy the second screen, depending if the teacher is presenting or publishing the class material. The teacher interacts with the application controlling a cursor with his hand movements relatively to his body.

Figure 2: TA main components.

3.1 Content manager

As the name suggests, through this component the teacher manages the class material (presentations, activities, exams, etc.). It has a desktop-like appearance with all the material organized on the bottom; this way the instructor at any time can select any file to open or publish it with a drag and drop gesture. There will be no need to waste time browsing through all the pages of a conventional web based course content manager and the teacher can control the exact moment when he wants to distribute the material. A desktop-like appearance that uses meaningful icons will be helpful for an intuitive interaction [1].

3.2 Student awareness

The instructor should be able to control the group state and dynamics at any time; this is why the student awareness component is always visible. For each student, the component displays information about the network stats so the teacher is aware of the quality of the streaming both are receiving. Additional controls allow the teacher to interact with the students in different ways:

i. Answer questions in public or in private.
ii. Organize and moderate a discussion forum.
iii. Organize the students in working teams.

3.3 Presentation control

One of the most important contents of a course is the presentations made by the instructor, especially in a knowledge presentation teaching model [1]. One of the most valuable characteristics of asynchronic courses is the time flexibility they give. This is why the presentation control tool is not only designed to control a presentation (move forward and backward through the presentation, highlight a specific part, etc.), the application will record the presentation giving to the teacher the possibility of creating tags at any time; this way students can review easily each one of the presentations at any time.

3.4 Cursor control techniques

The user interacts with the application through a cursor he controls with the hand. For the purposes of this study we designed and compare two interaction techniques to control the cursor. Depending on each technique the interface of the application controls changes.

3.4.1 Horizontal tablet metaphor

We called the first technique a horizontal tablet metaphor because the user can imagine that he has a control tablet in front of him horizontally and controls the cursor with the hand movement. The tablet is activated when the position of the non dominant hand is raised approximately to 90 degrees. The cursor position depends on the distance between the dominant hand and an imaginary plane relative to the body position. Using the vectors formed by the central line of the body and the forearm we define the X-axis, Y-axis and Z-axis from which the distance (x,y,z) is calculated respectively (See Figure 2).

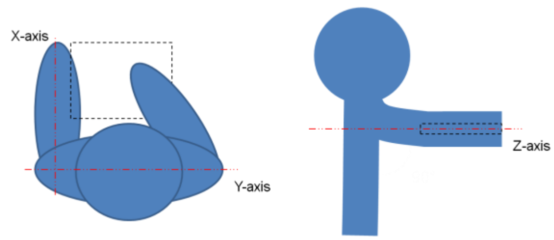


Figure 3: Horizontal tablet metaphor.

3.4.2 Vertical blackboard metaphor

We called the second technique a vertical blackboard metaphor because the user can imagine that he has the screen in front of him and controls the cursor with the hand movement. Using the vectors formed by the shoulders position and the central line of the body, we create three axis from where a distance (x,y,z) is calculated (See Figure 3). We enhanced this interaction technique with an action button in a glove that the user have in the dominant hand.

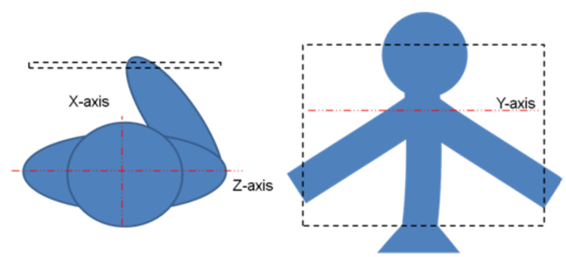


Figure 1: Vertical blackboard metaphor.

4 Evaluation and Results

We implemented the cursor interaction with both techniques (horizontal and vertical) to move forward and backward through a power point presentation to test the ease of use of the interface. We used the Microsoft Kinect as a 3D input device to track the user body. A group of 8 people (6 men and 2 women) between 20 and 23 years old tested both techniques; all of them teach at least one hour of class per week. Four of them started the test with the horizontal metaphor and four of them with the vertical metaphor. The test has 14 steps and ends with a survey designed to measure two levels of precision and the perception of the users. Every test is taken separately and lasts for about 10 minutes.

4.1 Test process

4.1.1 Step 1: Activate the cursor

In this step the user receive the explanation of how the cursor works. Once the user has adopted the correct position the low precision test starts.

4.1.2 Steps 2-5: Low precision test

The low precision test consists on moving the cursor to a green block that changes its position (see Figure 4). This procedure is repeated three times (steps 3-5).

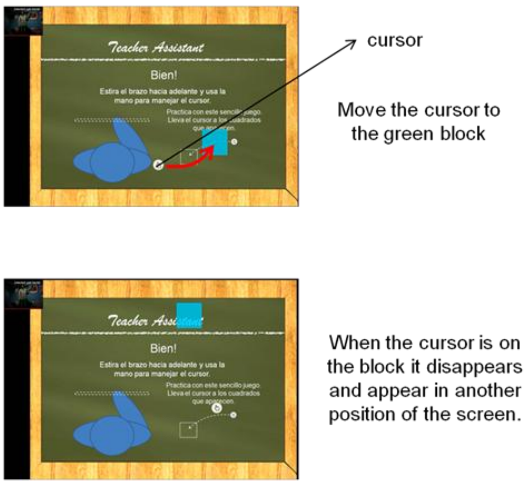


Figure 4: Vertical blackboard metaphor.

4.1.3 Steps 6-7: Close and open a presentation

Once the subject is used to the cursor control he is asked to close the actual presentation and open a new one that has the instructions to advance the presentation slides.

4.1.4 Steps 8-13: High precision test

To measure the performance in high precision tasks the user is asked to move forward through the presentation. Each technique has its own method to achieve that (see Figure 5). For the horizontal technique the user must slide the cursor from right to left in the bottom region of the screen. For the vertical technique the user must press the button[1] and move the cursor to the left. The movement from right to left is based on the current gesture to advance slides on a touchscreen device.

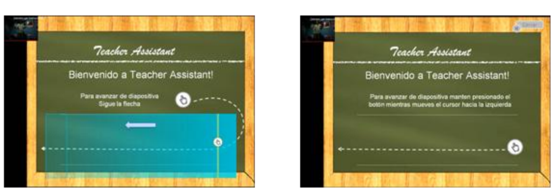


Figure 5: Vertical blackboard metaphor.

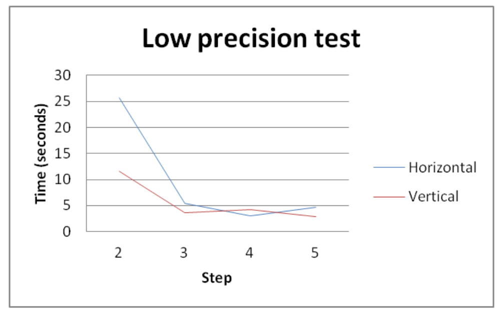
[1] In order to emulate the button we used the left click of a wireless mouse.

4.1.5 Step 14: Close the instructions and have fun

Finally, the user closes the instructions presentation and is uses the application freely with a real presentation.

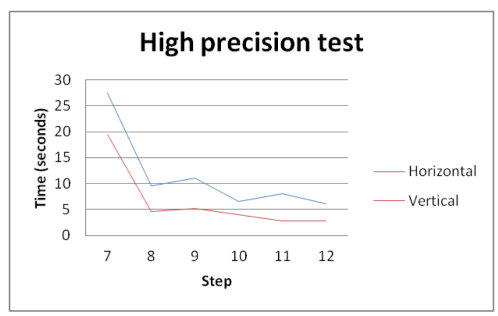
4.2 Results

To compare the techniques, the application measures the time between each step of the test. Although the sample size is not enough to do statistical inferences, these results give a first insight of the techniques behavior. As we can see in the next charts there is no significant difference between the techniques in low precision tasks, but in high precision tasks the vertical technique shows that an extra button is useful to improve the interaction performance. How you can see, the average value and the variance are lower with the vertical technique than with the horizontal technique.



Technique	Step 2	Step 3	Step 4	Step 5
Horizontal				
Avg. Time (s)	25,63	5,38	3,00	4,63
Std. Dev.	12,44	2,13	2,27	1,92
Vertical				
Avg. Time (s)	11,63	3,63	4,25	2,88
Std. Dev.	6,02	1,69	1,39	1,55

Chart 1. Low precision test results.



Technique	Step 7	Step 8	Step 9	Step 10	Step 11	Step 12
Horizontal						
Avg. Time	27,50	9,63	11,00	6,63	8,13	6,13
Std. Dev.	12,55	4,69	8,12	2,83	7,57	3,60
Vertical						
Avg. Time	19,43	4,57	5,14	4,00	2,86	2,86
Std. Dev.	7,52	1,27	3,08	1,15	1,07	0,90

Chart 2. High precision test results.

We used a survey to know the clearness of the instructions and the perception of the user. The results show that the 3D interface is comfortable but is not as easy to use as the expected. The high precision tasks demanded more coordination than the expected, and this should be avoided in order to hide the complexities to the user. Some subjects manifested their preference of the vertical interaction technique over the horizontal technique.

Qualify from 5 (Easy or comfortable) to 1 (Difficult or uncomfortable)	5	4	3	2	1	Avg.
1. open/close a presentation	12,5%	25,0%	62,5%	0,0%	0,0%	3,5
2. move between slides	25,0%	37,5%	37,5%	0,0%	0,0%	3,8
3. using the hands as a cursor	50,0%	37,5%	12,5%	0,0%	0,0%	4,3

Chart 3. Qualitative results.

All the subjects manifested that the application was interesting and that the eventually would like to use the platform to do an exposition of their own. This showed that a 3D user interface produces interest despite the difficulties in the precise interaction.

5 Conclusions and future work

The TA design we presented takes into account the most important features of a virtual classroom. It tries to make a correct use of synchronic and asynchronic methods in order to get better the performance of distant learning. Dividing the class management requirement into different components allow TA to offer a simple interface that gives face-to-face experience in an easy adjustable environment to support many kind of activities. A 3D user interface is interesting and motivating to perform better in the virtual classroom; however there are still some precision issues to solve.

There is still a good part of the project that must be implemented and tested. First, the user test showed that the Microsoft Kinect has several precision issues that must be solved even at hardware or at software level. Once the interaction technique has been refined, we can proceed with the other tools of the platform. Video streaming and recording, client side application and fast tools to set the interaction rules over the classroom (private chats, discussion forums, etc.) is the next step to conform the platform. 3D user interfaces based on webcams can enhance the interaction from the student side of the virtual classroom. TA shows that current advances in technology can enhance the experience in a virtual classroom for teacher and students.

References

[1] Z. Zhan, "A Review of Virtual Classroom Interface Designs," *International Conference on Educational and Information Technology (ICEIT 2010),* 2010.

[2] Y. Hu and G. Zhao, "Virtual classroom with Intelligent Virtual Tutor," *International Conference on e-Education, e-Business, e-Management and e-Learning (IC4E 2010),* 2010.

[3] M. A. Parker and F. Martin, "Synchronous Virtual Classrooms: Student perceptions from an online and blended education course," *International Conference on Technology for Education (T4E 2010),* 2010.

[4] R. M. Bernard, P. C. Abrami, E. Borokhovski, C. A. Wade, R. M. Tamim, M. A. Surkes and E. C. Bethel, "A Meta-Analysis of Three Types of Interaction Treatments in Distance Education," *Review of Educational Research,* 2009.

[5] C. Lu, J. Zhou, L. Shen and R. Shen, "Techniques for Enhancing Pervasive Learning in Standard Natural Classroom," *International Conference on Historical Linguistics (ICHL 2008),* 2008.

[6] F. Martin, "Best Practices for Teaching in a Synchronous Virtual Classroom," *International Conference on Technology for Education (T4E 2010),* 2010.

[7] J. Liu, J. Wang and N. Gu, "Several Critical Problems in a Real-time Interactive Virtual Classroom," *International Conference on Computer Supported Cooperative Work in Design Proceedings,* 2003.

[8] J. B. Arbaugh, "Virtual Classroom versus Physical Classroom: An Exploratory Study of Class Discussion Patterns and Student Learning in an Asynchronous Internet-Based MBA Course," *Journal of Management Education,* 2000.