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Virtualizing Real-life Lectures with vAcademia, Kinect, and iPad

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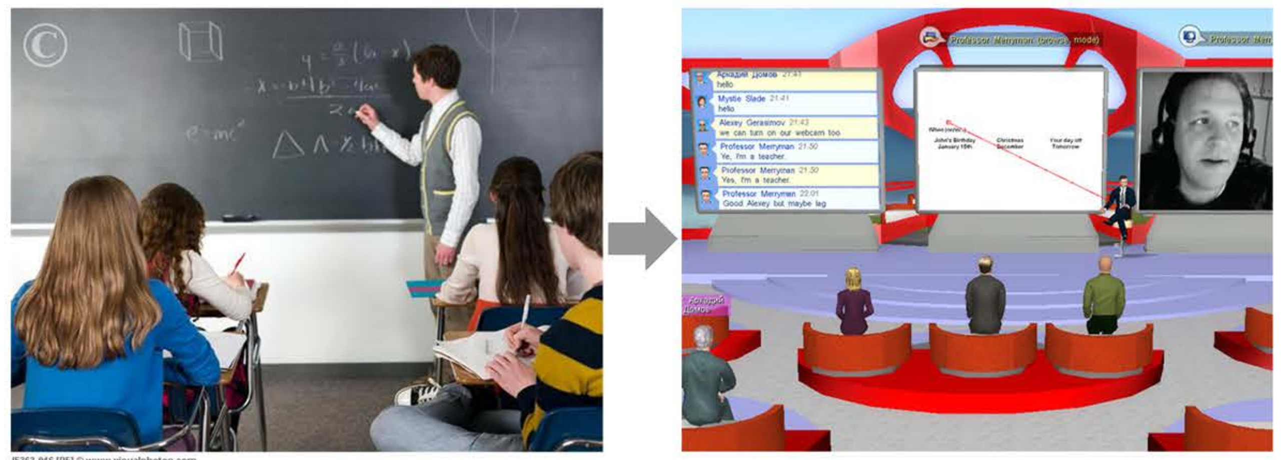
Objective

A low-cost technological setup for translating real-life presentations and lectures into a 3D virtual environment:
- Streaming real-life lectures into 3D virtual environment
- Automatically creating immersive 3D recordings



Technological Setup

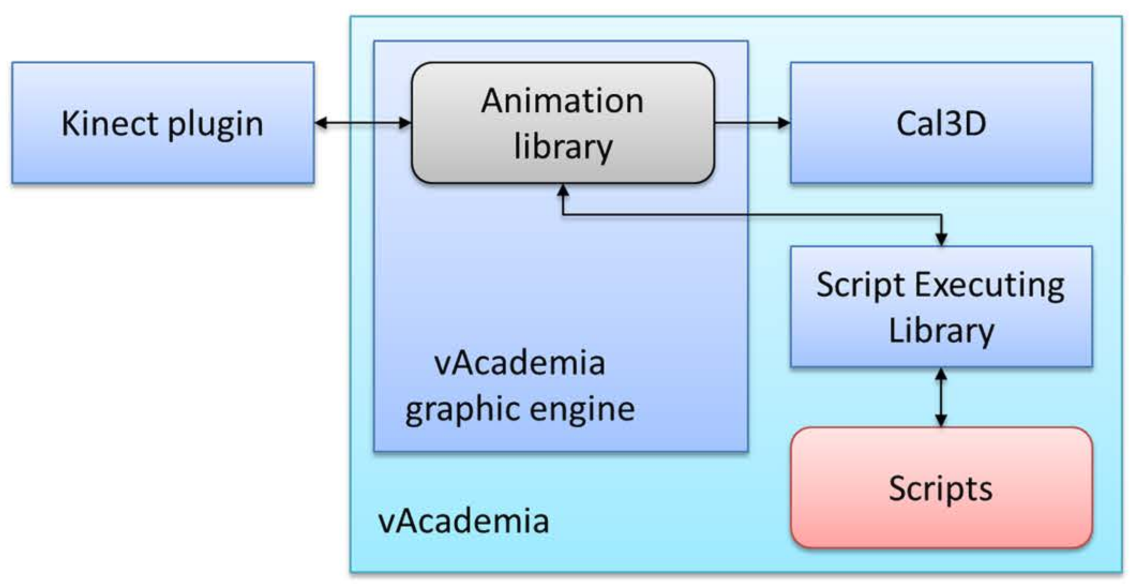
We use three available technologies to implement the proposed system, vAcademia, Kinect, and iPad. Kinect is used for capturing the movement of a lecturer, while vA-cademia is used for creating and recording the virtual replica of a lecture. In addition, the lecturer can use an iPad to control the environment and media content, such as drawing, switching slides, pointing, viewing the environment, and streaming in 2D.

KINECT for Windows   iPad

System Implementation

The virtualizing real-life lectures mode interface is implemented using vAcademia Scripts. The Scripts initiate the beginning and the end of this mode. They provide Kinect-related information, including the skeleton in 2D and the recognition status of body parts. They interact with the Animation library of the graphic engine through the Script Executing Library. The Animation library controls the lecturer's avatar using Cal3D based on the data from Kinect plugin.

vAcademia uses Cal3D library for implementing the skeleton avatar animation. It allows to control the skeleton of an avatar by constantly and automatically recalculating its polygonal 3D model to match the current state of the skeleton. In the first prototype of the system, the Animation library of vAcademia requested a set of key points of the lecturer's body from the Kinect-support plugin. If the lecturer was recognized by Kinect, Cal3D bones of the vAcademia avatar are oriented according to the key points. The system supported a 'sitting mode', when the motion-capture data were used for orientating arms and head and a 'standing mode' for all body parts.



We conducted several evaluation sessions in several auditoriums with different configurations and lightning. The major evaluation data source is an interview with the lecturer. The following feedback on the technological setup is the most common:

The system applies too many restrictions on the lecturer's movements. Second, the lecturer has to face the device and not turn. Third, the lecturer has to use only one hand for pointing at the screen. Fourth, the lecturer has to avoid gestures that are difficult to recognize by the users of the 3D VW.

Motivation

Various advanced Virtual Reality (VR) technologies are being developed or adapted for learning and training, mostly in indus-try, military, and healthcare. However, a broader deployment re-quires the development of low-cost off-the-shelf solutions.

Background

Many studies report the potential of three-dimensional virtual worlds (3D VWs) for educational activities. In this work, we explore new ways of using 3D VWs for creating asynchronous content out of synchronous learning activities. Several tech-niques were adapted by educators for getting content out of traditional classes, such as video recording of face-to-face lectures and recording of webinars. Such recordings change the context of learning and do not provide a possibility for collaborative work or for further developing the content, except for annotating. 3D VWs are used for generating educational content too. However, activities there are usually recorded as 'flat' 2D video, eliminating many advantages of the technology.

Low-cost motion-sensing technologies such as Microsoft Kinect, Nintendo Wii Remote, and Playstation Move provide researchers and educators with new opportunities for improving learning. Multiple examples include a low-cost alternative for interactive whiteboards and multi-touch teaching stations designed based on Kinect.

Tablets, like iPad, and other mobile devices are starting to be used for augmenting 3D VWs. A tablet provides a more convenient interface for a VR application than mouse and keyboard, especially if the user wants to stand and move.

Motion-capture Challenges

The evaluation of the first prototype revealed three major limitations of the given context and three corresponding challenges for the system implementation.

- C1: Kinect does not capture the gestures accurately enough. Therefore, we could not build a reliable avatar model and exclude unnatural poses.
- C2: Kinect does not recognize the turn of the lecturer. If the lecturer turns away from the device, it mixes up the left and the right.
- C3: An obvious, but serious challenge for applying Kinect is its inability to capture parts of the body that are covered by other body parts or foreign objects.

Whiteboard-control Challenges

Based on the results of the system's first prototype evaluation, we have identified the following challenges for controlling virtual whiteboards and their contents.

- C4: The position and movement of the lecturer against the physical whiteboard should match the position and movement of his/her avatar against the virtual one.
- C5: A physical pointer needs to be captured and represented in the 3D VW, where it is often even more important. However, Kinect cannot capture a physical pointer.
- C6: Switching the slides requires interaction with the computer or a remote control, which does not convey any meaning when captured and translated into the 3D VW.

Learning Scenarios

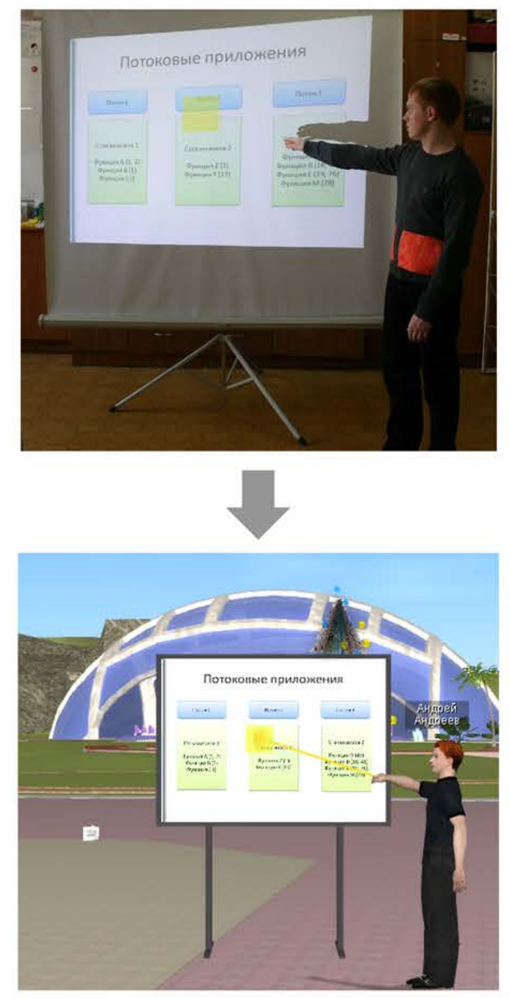
- Lecturing in Mixed Reality. A live lecture is attended by the learners in real and virtual worlds. This provides distant learners with a greater sence of presence and possibilities for interactions with students in the physical classrooms.
- Round-table Discussion as a Mixed Reality Activity. Some of the participants can join through the 3D VW, while some other can be captured from the real world through multiple Kinects.
- Mixed Reality Educational Role Plays. Pparticipants from the physical and virtual classrooms engage in a typical or difficult situation. It allows creating and recording shared virtual scenes of role plays, but with two Kinect users at a time.
- Immersive 3D Recordings. Motion capture is used for easy and low-cost creation of educational content for later (asynchronous) use, such as lectures and simulations. The realization of this scenario can provide an advanced alternative to the video-recorded lectures, as it combines the convenience of video and immersive qualities of 3D VWs.

Addressing Challenges

We addressed C1 by introducing several mechanisms. We limited the distance between the Kinect device and the lecturer. In addition, we fixed the Kinect device at a 0.5 meters distance from the floor. We introduced an additional filtration mechanism for sorting out unnatural positions, separating hands as distinct body parts.

We addressed C2 by implementing the following algorithm. The turn is recognized relatively as a function of the position of the pelvis end points. The resultant value is valid within the range from -110 to 110 degrees against the "facing Kinect device" direction. We introduced colored markers for better recognition of the turns.

Challenge C3 may be addressed by applying multiple Kinect devices. At the same time, new challenges may appear, such as the increase of the price, complexity in setting up the system, and complexity in merging the data from multiple sources.



Addressing C4, we introduced a Setup mode for achieving the precise match between the physical and the virtual whiteboard (horizontally) and installing Kinect at 0.5 meters from the floor (vertically).

Instead of trying to capture the physical pointer, we direct the virtual pointer based on the position of the lecturer's hand, addressing C5. If the half line that extends from the lecturer's hand crosses the physical whiteboard, the avatar in the 3D VW directs a virtual pointer to the same point. In order to keep the lecturer aware of his or her hand being captured, we display a semi-transparent yellow area on the physical whiteboard on top of the slides.

Addressing C6, we have been developing the switching slides functionality by recognizing standard Kinect gestures Swipe Left and Swipe Right. In addition, we decided to employ iPad for extending the possibilities of controlling media contents. Using vAcademia Presentation Remote app, the lecturer can stream handwriting and drawing to a virtual whiteboard and control other content on it without going back to the computer. The tablet is connected to the vAcademia client software through the vAcademia communication server using access code.

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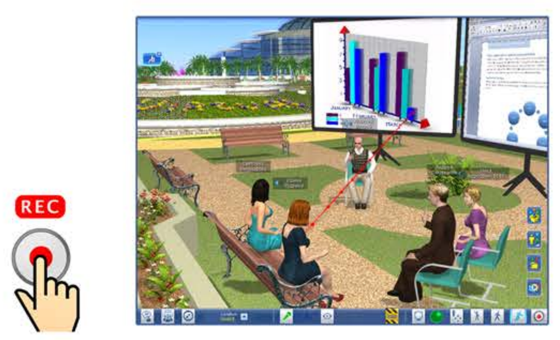

- Prepare for a role play
- Press Start 3D recording
- Session is being recorded
- Conduct the role play

STOP

- Press Stop 3D recording
- 3D recording is created
- Share 3D recording
- 3D recording is available for revisiting

- Record several role plays
- 3D recordings are organized
- Use 3D recordings as a course content

STOP