SPHERICAL VIDEO RECORDING AND POSSIBLE INTERACTIVE EDUCATIONAL USES

Emrah Emre OZKESKIN
Aksaray University, Aksaray, TURKEY

Assist. Prof. Dr. Tuncay TUNC
Aksaray University, Aksaray, TURKEY

ABSTRACT

Although videos are common instructional materials, traditional videos don't let users to view the environment from different angles and there is no interaction. On the other hand, creating virtual interactive environments are expensive, time consuming and also it's difficult to create environments which reflects the real world. Spherical videos have the advantage of reflecting the environment as it is. It takes less time and effort to record. There is no need for an extra player or software other than Adobe Flash based players to display interactive spherical videos. Video files can be streamed over the internet or can be transferred using flash disc, CD etc. Recorded spherical videos can also be used in 3D applications as background.

Interactive Flash Panoramic video, by the help of approximately 360° view, lets user to focus any point on the screen he/she wishes by using his/her mouse while video is playing or stopped. Learning can be strengthened by watching the video multiple times from different angles. As an addition to these, embedding objects (sound, picture, text, graphic, movie, and links) makes panoramic videos interactive. Learner has unique learning experience by interacting with the objects during the film.

In this paper, interactive video was created using a spherical video camera discussed employing the example of educational uses. For this aim, the videos which were shot by using spherical video camera were made interactive using Ladybug PRO, Lucid Viewer and XML. This study shows how spherical videos can be prepared as an instructional material.

Keywords: Spherical video camera, education, panorama, interaction.

INTRODUCTION

Using materials in education brings the actions, concepts and objects which are impossible to bring to the classrooms. What makes learning materials so important is linear relationship between sensory organs and learning. According to the research, students' learning is facilitated by seeing 83%, hearing 11%, smelling 3,5%, feeling 1,5% and 1% tasting. According to this information we can say that seeing is a major factor for learning (Yalın, 2000).

One of the mass media which has been developed until today for education is video. On educational perspective video is seen as a multi-dimensional and general means of communication. Video has the ability of changing, transmitting, reflecting and presenting coded meaningful knowledge patterns. New technologies on hardware and software can be seen each passing day and these new technologies are used for education. The use of video in education is not new, but, is diversifying rapidly as technological developments make video conferencing, video on compact discs and 'interactive video' more widely available (Garvin & Carrington, 1997; Laurillard, 1995; Whalley, 1995; Shephard, 2001). However, the media and the audience have changed in recent years. Fedale (1982) showed that a well-prepared and presented video lecture could be effective for corporate training purposes and in higher education settings. With the capability to put sound and motion

pictures together, video is a very powerful communication media and a very effective information transfer material.

Therefore, many educators use videos in their instruction programs and courses as well as recording videos outside the class and bringing them to the class. In the meantime, they can use videos in web sites and DVDs. The ability to stream video over the web, rather than relying on the distribution of physical video tapes or cable and satellite links, has created the opportunity for greater numbers of students to be involved in distance learning (Fedale, 1982).

Video has been used 'off-line' for many years to support student learning in a variety of settings. Recently technological advances can make it available 'on-line' and 'on demand'. Video can be 'streamed' over the Internet to users who request it, for example, by clicking on a hyperlink within a web page. Users do not need to download the video, which starts to play soon after the request is made (Gren, et al., 2003). Carr-Chellman & Duchastel (2001) assert that there are two purposes for using video within a Web-based course. The first is to motivate learning and the second is to enhance the students' identification with the course content.

To accomplish these purposes, the instructor must effectively deliver the content of the video presentation. The literature furthermore suggests that theatrical skills are essential in an effective video lecture environment regardless of an instructor's knowledge of the subject matter (Russell, et al., 2007).

Today, various technologies can be used for education. One of these is 3D learning environment designs. The aim of these environments is to create more realistic and interactive learning environments. But the cost of creation of these environments is high and takes a long time to design. At the same time, some problems (models don't fit the real ones, big environment models need powerful computers, causing misconceptions in students, need of a special software etc.) may be faced with when transferring real life situations to the educational environment.

Since 1990s Internet has a major impact with an expanding expectation that it will become the main power of school development. In addition, panoramic pictures have been much popular in recent years. With the help of special video recording hardware and photographing techniques, photos can be obtained with a wider angle. After processing these photos with high technology firm wares and stitching them together, the image obtained is called panoramic image. In this way, all the space is enabled to show in one photo with an angle of 360°. Panorama can be applied in a painting, drawing, photograph, film/video or 3D model.

The tradition of taking a circular series of photos from a single focal point in order to show broad views originated in the mid-19th Century. These sets of photographs were often joined together into a single panoramic image (Gancarson, 2006). Shortly, after the invention of photography in 1839, the desire to show overviews of cities and landscapes prompted photographers to create panoramas. Early panoramas were made by placing two or more daguerreotype plates side-by-side. In the late nineteenth century, cameras were manufactured specifically for producing panoramas.

These cameras were either swing-lens cameras, where the lens rotated while the film remained stationary, or 360-degree rotation cameras, where both the camera and the film rotated. The first mass-produced American panoramic camera, the Al-Vista, was introduced in 1898. Mass-produced panoramic cameras worked on the swing-lens principle, used roll film, and did not need a tripod.

Mass-produced panoramic cameras made small panoramas, measuring no more than twelve inches long with a field of view of almost 180-degrees. Developing the film was easy, and the resulting negatives could be contact-printed or used for enlargements. The circuit camera used for taking panoramic photographs was patented in 1904.

It used large format film, ranging in width from 5" to 16" and was capable of producing a 360-degree photograph measuring up to 20 feet long. Both the camera and the film rotated on a special tripod during the exposure.

Circuit cameras were used mostly by commercial photographers to capture city views, group portraits, and special events (The Library of Congress, 2010).

VIDEO PANORAMAS

The term motion picture (pan, panning, panama; the image obtained by rotating the camera) was derived from panorama. Video panoramas are linked together to enable the user to create their own narratives through the virtual handling of 3D artifacts, located in panoramic environments. This technology can be used to produce different kinds of instructional materials. (For example,) using video panoramas, geological, geographical, touristic and historical instructional materials can be created. Approximate spherical video image, enables the person to watch the video in a routine way as well as heading to one point by moving the cursor whenever she/he wants.

The same video can be watched from different perspectives again and again. Similarly, using a camera mounted on a helmet, real actions like distinguishing a fire, hostage rescue operations, or simulated military operations can be recorded. By creating interactivity, these panoramic videos can be used for pre-service or in-service education of fireman and security staff.

Also, video panoramas can be used on the Web to provide virtual tours of hotels, museums, exotic travel destinations, and the like. Discretely from normal video, video panoramas, present the whole environment and only the user decides what part of the surrounding environment or action to watch or observe in more detail (Kwiatek & Woolner, 2009). Besides, video panoramas can be 'played' in panoramic viewers providing the user the ability to navigate a scene through the rotation and zoom functions (Huang, et al., 2008).

Recent developments in camera technology and computer software make it possible to record not only 360-degree views of an entire scene but also to record 1 to 30 panoramas a second creating spherical panoramic video. The process of recording 360-degree video is achievable with a spherical video camera. Panoramic viewers; Panorama Flash Player, KrPano and Lucid Viewer based on Adobe Flash Player are supported by many platforms: Windows, Mac and Linux. These viewers work with XML files (Kwiatek & Woolner, 2009).

Spherical video recording
Ladybug 2 and *Ladybug 3* (Figure: 1) manufactured by Point Grey Research are 360º spherical digital video camera systems that have six cameras that enable the system to collect video from more than 80% of the full sphere, and an IEEE-1394b interface that allows streaming to disk at 30fps. While some computers may provide a built-in IEEE-1394a port, 1394b ports are less common.

The 1394a interface lets a data rate of 400Mb/s. On the other hand, 1394b interface doubles the data rate of 800 Mb/s. *Ladybug* images are saved in sets of stream files that are written to the hard disk of the laptop at up to 80 MB/sec.

To accommodate this input, it is recommended to use a laptop configured with striped disks, such as provided by a RAID 0 configurations.

The Ladybug cameras require 8 -30 volts of power. (Ideal voltage is 12V.) Since the IEEE-1394b ExpressCard for notebooks does not provide any power to the camera external power is needed.

If the notebook computer includes a built-in 1394a port with 6 pins, or any 1394b port, power can be supplied directly to the camera through the FireWire cable. *Ladybug 2* has 0.8MP cameras where as *Ladybug 3* has 2.0MP cameras.

Figure 1
(a) *Ladybug 2*   (b) *Ladybug 3*   spherical digital video camera system from Point Grey Research

Using *LadybugCapPro* software, GPS NMEA data can be inserted into *Ladybug* images. The data can then be extracted at a later time to generate HTML data as a Google Map or KML (KML is a file format used to display geographic data in an Earth browser) data for Google Earth. So the user can see/follow the coordinates on google map as s/he changes position in the movie (Point Grey Research, 2010).

Processing the video
Videos are saved in PRG format. Using *LadybugCapPro* software, the file is converted to AVI. Then the video is encoded to FLV to display on the web browsers and to be able to create interactivity.

To create interactivity, XML tags are used and photo, text, image, sound files are embedded.

Spherical videos are displayed like in Figure 2 on standard video players.   To display the spherical video in three dimensions, special video players like Lucid Viewer video player software should be used. Lucid Viewer is a 3D compositing engine for building interactive, immersive environments (Villmer, 2010). It supports both video and image content and includes compositing capabilities for incorporating interactive objects.

Figure 2
A scene from a standard video player

THE AIM OF THE STUDY

The aim of the study was to create an instructional material about earthquake. Since researchers did not have spherical video camera, movies were downloaded from the CNN, Immersive Media web sites. The software used for displaying the videos and interaction is unregistered copy of Lucid Video Player. Lucid video player can display spherical videos in spherical view different from ordinary video players. By facilitating XML tags, interaction was created.

There are some Lucid viewer tags to create interactivity. The tags we used are:
➢ scene
➢ object
➢ overlay
➢ model

Scene tag

Scene tag was used to show immersive environment. Each scene is represented by a number, 1, 2, 3 etc. There are some parameters used with this tag.
➢ file: Path to spherical image or video file
➢ name : Scene name
➢ bar: sets bar mode for science
➢ play: plays video science automatically
➢ loop: loop video science automatically

Here is an example usage of this tag:

```
<?xml version = '1.0'?>
<lucid>
<viewer mouse="track" bar="true" tooltips= "true" toolpanel=""/>
<scene file="sahne1.flv" name="Deprem Sahne 01" play="true" loop="true" </scene>
</lucid>
```

Object tag

Object tag is used to show three dimensional elements placed inside spherical elements. Objects are added before the </scene> tag. There are some parameters used with this tag.

➢ File : path to object (image, video, or flash) file.
➢ Scale: Object size
➢ Time: Object in and out time values in seconds.
➢ Text: Mouse over text, color. Color is optional.
➢ Glow: Object glow color (on mouse over)
➢ Focus: Camera pans to object at it's in time, on mouse over, on mouse click
➢ Scene: Load scene # (on mouse click)
➢ Link: Load URL (in -blank window or -self) or send e-mail
➢ Popover: Mouse over opens pop-up using image, video, flash or text file
➢ Video: auto-play, loop, auto-close video file
➢ Video-action : Performs a video related action upon mouse-down:
• toggle
• rewind
• back
• forward
• end

Here is an example usage of this tag:
```
<overlay file="resimler/deprem1.jpg" align="lb" x="" y="" alpha="" scale=".2" text="" glow="" blend=""
scene="" link="" popover="" popclick="" camover=""
camout="" camclick="" audio="" project="" video_action= "" scene_action= ""/>
```

Overlay

Overlays are two dimensional objects in a fixed position on the screen. There some parameters used with the tag:
➢ file : Path to object image or flash file
➢ align: Overlay's screen location:
• lt : left top
• lm: left middle
• lb: left bottom
• ct: center top
• center: center
• cb: center bottom
• rt: right top
• rm: right middle
• rb: right bottom
➢ scale: Overlay size
➢ text: Mouse over text

➢   focus: Camera pans to Object at it's in time, on mouse over, on mouse click
➢   Load scene # (on mouse click)
➢   Load URL (in _blank window or _self) or send email
➢   Mouse over opens pop-up using image, video, flash or text file
➢   Video action: Performs a video related action upon mouse-down:
•   toggle: Toggles video playback (play/pause)

An example usage from our study of this tag
<overlay file="resimler/depremNedir.png" align="lb" x="" y="" alpha="" scale="1" text="" glow="" blend="" scene="" link="" popover="" popclick="video/deprem.swf" camover="" camout="" camclick="" audio="" project="" video_action= "" scene_action= ""/>

The first video was thought as an introductory menu. There were links to the other videos, information about us, to the Bogazici University Kandilli Observatory and Earthquake Research Institute (KOERI) National Earthquake Monitoring Center (NEMC) web site (current earthquakes in Turkey), e-mail, staff, help and on the bottom right of the screen to the Aksaray University web site (Figure3).

Figure 3
Introductory screen

When the user moves his/her mouse over the icons, a short description becomes visible. When the animation pops up or the user clicks on the button on the screen, an earthquake animation (a flash animation file) is displayed (Fig 4). The User can read, animate and replay this informative object as many times as she/he wishes and anytime appropriate.

Figure 4
Instruction screen

Using XML, different objects like videos can be embedded into the spherical video. In the example the New Bay Bridge video was embedded (Figure 5).

Figure 5
Embedding another video

By the help of the interactive video (dragging, clicking, using embedded flash files, pictures etc.) user can observe the earthquake better. The users can pause, rewind, play and inspect the very same environment from different angles, and two more different videos about Poland Krakow and New York were also added. Watching these movies, the users can imagine and compare cities, architectural differences and make assumptions what may happen if similar earthquake happens in these cities.

CONCLUSIONS AND IMPLICATION

Using interactive spherical video for education is different from using traditional video or traditional interactive environments. Viewers of panoramic video become virtual participants immersed in the observed scene,

creating a new interactive dimension in the way people perceive video imagery within a "virtual environment" (Pintaric, et al.,2000).

Traditional videos do not let users to view the environment from different angles and there is no interaction. On the other hand, creating virtual interactive environments are expensive, time consuming and also it is difficult to create environments which reflects the real world. Spherical videos have the advantage of reflecting the environment as it is. It takes less time and effort to record. There is no need for an extra player or software to display interactive spherical videos. Video files can be streamed over the internet or can be transferred using flash disc, CD etc. Recorded spherical videos also can be used in 3d applications.

Embedding different objects (sound, swf, fla, text and video files, direct texts) transforms videos from passive learning material to highly interactive learning materials. It is obvious that a user cannot walk or move to any direction s/he wishes. But assigning appropriate keys and video files, the user can walk in permitted space and direction. Flash files can gather information about the user and track his/her progression.

Shooting experiments, straining or real life actions using spherical panoramic cameras also help researchers to investigate more deeply and controlled way. While shooting an action or an experiment using ordinary cameras, researchers may miss an important scene. Since, spherical cameras record approximately whole scene (more than 80%), recorded video can be investigated several times from different angles.

BIODATA AND CONTACT ADDRESSES OF AUTHORS

Emrah Emre OZKESKIN graduated from Foreign Languages Department of the Faculty of Education of Çukurova University and received his master degree from Computer Education and Instructional Technologies Department of the Institute of Social Sciences of Çukurova University. Currently serving as an Instructor at CEIT Department of the Faculty of Education of Aksaray University.

Emrah Emre OZKESKIN
Department of Computer and Instructional Technology
Faculty of Education
Aksaray University, Aksaray, TURKEY
Tel: +90505.2541708
Fax:+90.382.2801180
E-mail: eozkeskin@hotmail.com

Assist. Prof. Dr. Tuncay TUNC graduated from Physics Education Department of the Faculty of Gazi Education of Gazi University and received his master degree from Physics Education Department of the Institute of Sciences of Gazi University and received his Ph.D. degree from Physics Education of the same institute. He worked as a physics teacher in high schools for 13 years. Later, he worked as an author and commission chairman for science and technology textbooks in Republic of Turkey Ministry of National Education for 4 years. Currently serving as an Assist. Prof. Dr. Science Education Department of the Faculty of Education of Aksaray University.

Assist. Prof. Dr. Tuncay TUNC
Science Education Department
Faculty of Education, Aksaray University
Aksaray, TURKEY
Tel: +90506.5057102
Fax:+00.382.2801180
E- mail: tctunc@gmail.com

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