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Developing screencasts and video screencasts for e-learning

Carlos Turro, Luis Morcillo and Jaime Busquets
Universidad Politécnica de Valencia
Spain

1. Introduction: screencasts & video screencasts

In 1995 Udell defined a screencast as a digital movie in which the setting is partly or wholly a computer screen, and in which audio narration describes the on-screen action. (Udell, 1995). Since then, thousands of screencasts have been recorded by internet users and software companies as tutorials, how-tos and demos.

While the popularity of this medium should be a measure of its quality, screencasting has been barely used for e-learning. E-learning products have preferred the usage of slides, or products based on slides, for a variety of reasons. Slides allow a more structured training, are easier to prepare, and maybe the most important reason, teachers are very comfortable in using slides.

So, applications like PowerPoint or Keynote have the feature of "narrated presentations" in which a presenter can record his voice with the pace of slides. This recording can be played later.

A concern in both solutions is that we don't see the image of a teacher. After all, when we go to a standard presentation we see the teacher or the presenter and we think it's important for us to see him and his gestures, not just getting the slides and his voice.

A layout including both a slide channel and a video channel showing the teacher, when delivered on a web page is called a webcast. So, webcasting applications use a slide and presenter layout to accommodate on a webpage of resolution no less than 800x600 both channels of information and a medium bandwidth. We will review some of them later.

Finally we could think on a convergence of the screencast model with the webcast model, then we can get the presenter or teacher y a screen capture of his computer into a web page that can be delivered over a limited bandwidth Internet connection. This setup is what we call a video screencast.

In this chapter we will review first the main characteristics and examples of webcasting products, and then we will present the Polimedia application from the Polytechnic University of Valencia, as an example for a video screencast application. Then we will address how this content can be delivered to mobile devices. After that we will present some tests regarding the quality and the usage of video screencast content and will finish this chapter with the conclusions on the work presented.

2. Content design for webcasting and video screencasting

When producing webcast content, we usually have a screen layout similar to the one that we present on figure 1. We have on the left (or maybe right) side of the webcast application a window of 320x240 in which we have a video of the lecturer and, in 640x480 or 800x600 pixels we have a "slide" window in which students can follow the slides of the presentation. Using the same layout, an alternative approach is to use the slide window to present screen captures of a software application, typically the teacher's PC screen.

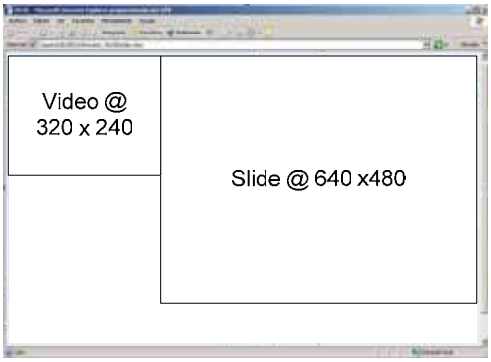

Fig. 1. Usual webcast screen layout

In this layout, the video channel is broadcasted using a standard streaming codec, while the slide channel is sent usually in an asynchronous way, using a standard format, like PNG. Here is important to remark that for the slide channel a lossless codec should be used, because the slide channel has text, and text is a set of thin lines that are smeared by lossy codecs, like JPEG.

A good example of webcast applications is Microsoft Producer, that is a PowerPoint extension written by Microsoft.

PowerPoint slides are the basic source that can be used within a Producer presentation, and the Producer add-on for Microsoft PowerPoint allows users to capture and synchronize audio, video, slides, and images, preview them, and publish them for viewing in Microsoft's web browser. The output is HTML and Windows media video, with an optional XML description of the HTML files to enable a SCORM compatible learning management system (Dodds & Schawn, 2004). Figure 2 shows an example of a Producer presentation.

Fig. 2. MS Producer example

There are other similar webcasting products, and we can talk, as a reference, of Adobe connect, D-Lecture from the University of Bremen (Bodendorf et al, 2005) or the MIT webcast application (Huang et al, 2003). These applications work in a similar way as MS Producer having some advantages, mainly in terms of open distribution or open source licenses.

Another layout, which we use in our own video screencast application, called Polimedia, is to use a left slide window of 800x600 pixels in the left side, and a right video window of 320x480 pixels in portrait layout (figure 3). On such layout, lecturer can be fully captured and, by means of video chroma-key technique, he can stand on a more natural way near the slide show. It is also worth mentioning that the slide window is better used as another video stream, but with a lossless codec, giving low frame rate, but high resolution. So we get both smooth video and slide quality on the receiving side.

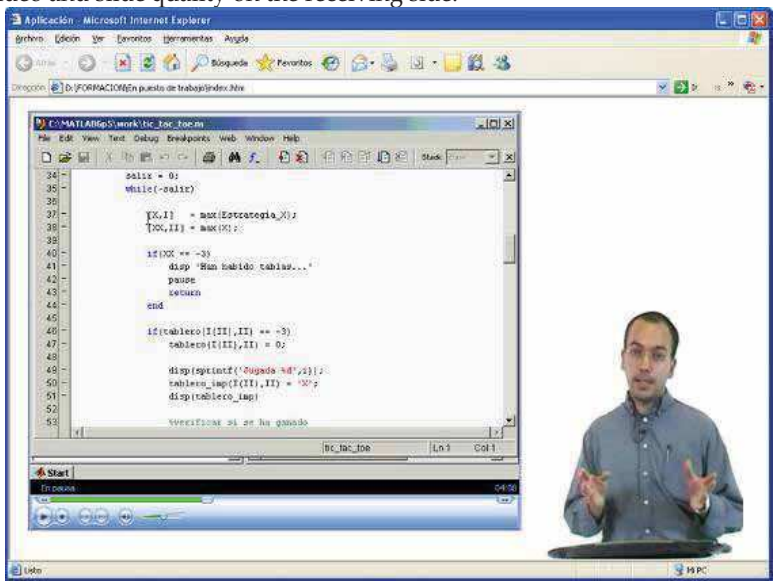

Fig. 3. Polimedia interface

Thus on the final product we have two windows on the PC screen. At the right side there is the teacher's image, captured with a resolution of 320 x 480 pixels and 25 frames per second, and at the left side is the PC's image, captured at a 800x 600 pixels resolution and 5 to 10 frames per second. Both streams are synchronized.
So, the right side is specially designed for slowly moving content, like slides, and computer demos, but also can display live video at a slow frame rate. The use of this slow frame rate allows us to use a lossless video codec, to achieve sharp images of the computer screen or, in the case of using a lossy codec to achieve more compression ratio, use a set of video compression parameters that allow us to maintain such video quality. On the other hand, teacher's video is compressed using a standard lossy codec, which provides us smooth movement and high compression ratio.
From teacher's point of view, recording a Polimedia object is as easy as arrive with a Powerpoint file, a laptop, or even a URL to our recording studio. There are two screens, on at the front of the teacher, and one at the right. In such position he or she will record the lesson and both streams will be recorded. In figure 4 you can see the set up for the studio with a photo of a live recording. Those sources are combined as shown previously to be broadcasted or recorded for future use.
Delivery of content is done through a web page that synchronizes two video streams through MMS streaming or a Flash Streaming Server In fact we don't use any proprietary capability of the Flash Server, so we can use an Open Source Flash Server, like Red5 (reference). The overall bandwidth of a Polimedia recording is of 512 Kbps.

Fig. 4. Live recording on a Polimedia lab

At Polythecnic University of Valencia we use Polimedia jointly with our Sakai e-learning platform, while Polimedia can be used with any other e-learning platform, like Moodle. At today's date, 2814 Polimedia objects have been created by 228 different teachers on 6 dedicated production studios. All of these objects can be accessed through the Sakai e-learning platform of the University, extending its capabilities.
To allow the students to follow the subject we create a syllabus of the course content. This syllabus is stored on the Sakai E-learning server and points to the Polimedia clips, and students are to decide themselves when and how much time they want to allot to syllabus processing. The syllabus is divided into smaller units which can be processed in 10-20 minutes, therefore students' attention is ensured.

Students' work is directed jointly by the structure of the syllabus and navigation opportunities, so they need to be easily manageable and logically structured. The easy processing of the syllabus is ensured by jointly using Polimedia with a varied set of media (animation, video, ands simulation exercises) through any external e-learning platform.
In the case that a course will only use Polimedia resources we recommend to structure the course in modules, and the in lessons, as seen on figure 5. Each lesson will address just one concept.

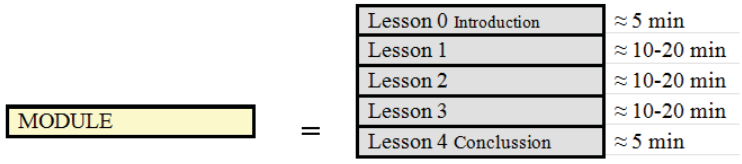

Fig. 5. Structuring a Polimedia course

Before each syllabus module, the students' level of knowledge should be tested by the e-learning platform to decide whether processing the particular syllabus is necessary or not. End of module testing is to show the success of knowledge acquisition. We made testing online through our Sakai platform.

3. Developing video screencast content for mobile devices

Mobile devices place special constraint for webcasts and video screencasts. Usually content for mobile devices has to be developed specifically, because of the limitations in size, processor speed and bandwidth of the receiving devices.
In order to reuse webcast content on mobile devices we have designed and tested an expert system that packs all media content into a video stream than can be viewed, at a 320x240 pixels video resolution (QVGA), and received on most smartphones and PDAs.
We have been unable to find similar systems on the literature. Machniki (Machniki et al, 2002) proposed an expert system to automate video switching on webcasts, and our idea is somewhat similar, but in a different context. Also Mukhopadhyay (Mukhopadhyay et al, 1999) proposed an expert system to segment video webcast content. Our system applies similar ideas specifically for mobile devices.
Our goal is to transform the original content from its initial state to a new state (new structure with new media formats) that takes into account the constraints of limited devices. Unfortunately, such techniques are usually not sufficient to guarantee a correct handling and presentation of the adapted content in particular for limited devices such as smartphones.
So, what we have done to produce quality content from both streams (slide and video) is to merge those streams into a smaller one, but positioning the video stream where there is less overlap with the slide content. As slide content is not static, we will change video stream location and size during the webcast. After this smart merging process we will compress the final stream using a 3gpp or mpeg-4 video codec. This process is depicted on figure 6.

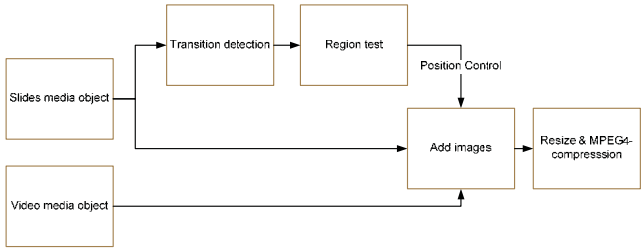

Fig. 6. Processing content

In order to do this process in a computationally feasible way, we have designed an expert system that uses four layout regions controlling the position, size and scaling of video media object into slide media object. Then video object overlapping is computed for each one on each slide transition, and the region with less overlap is selected. If none of them can be used, we will delete video, but not audio, from the slide stream until next transition.
Our layout regions are, as shown on figure 8, on the left with full body, on the left with half body and the same on the right side.

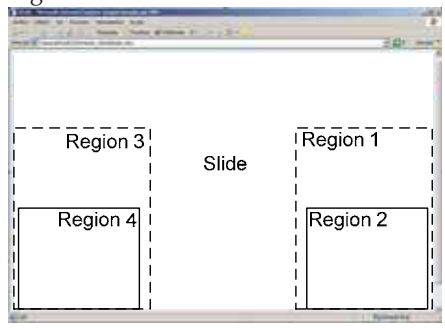

Fig. 7. Video regions.

In order to test our system we have performed two main tasks. First of all we have done an implementation of the system using MATLAB for scene detection and to select the best region between the four possible location and zoom combinations and then we have used Adobe Premiere Editing Decision Lists (EDL) feature to write a script that reformat and compresses all the content. A sample of an EDL for an e-learning content of about four minutes is shown on figure 8.
On that figure we can see thumbnails of the slide channel content and which region has been used for that content. It is necessary to point out that due to some limitations on Adobe Premiere, thumbnails on slide channel are presented at same size while there is a transition at some point in the middle of a thumbnail. For instance, the first transition point between Region1 and Region2 on figure 5 lies at 00:40, and is correctly presented at Region1 and Region2 channels, but it is incorrectly seen at slide channel.

Fig. 8. Editing Decision List

Anyway we also see in this example that right-side regions are more used than left-side ones. This is reasonable because western languages are written left to right. In fact we have only used left-side positions on graphic slides.
It is also true that not all regions are used equally. In Table 1 we summarize our percentages after converting about 10 hours of slide and video content.
After that we have tested the quality of our process by means of a survey in order to find if people can follow properly the e-learning lesson. To achieve this we have compressed some videos to VGA size (640x480 pixels), QVGA size (320x240), for Smartphones and 176x208 pixels, as in most mobile phones. We have used VGA screen size content for reference and we investigate on the requirements for Smartphones and mobile phones. All videos have been encoded at 15 fps.

Region	% use
1	28%
2	42%
3	4%
4	10%
5 (none)	16%

Table 1. Region usage

So, taking as reference some content that users can follow properly at VGA resolution, we have asked our testers about the smallest character size they see comfortably. Results of this survey, shown on figure 9, show that most content can be read well on Smartphones, because people can see content written on a text font of 16 pixels size. On mobile phones we need a text font of at least 20 pixels size. This result means that if we want to develop content for mobile phones we have to design slides carefully and we can't reuse our original content directly.

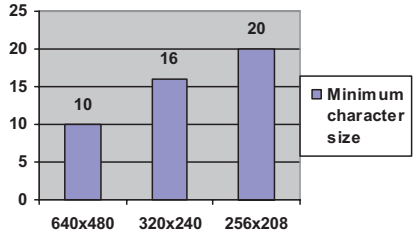

Fig. 9. Minimum character size

So we see that mobile phones can be too small for this kind of application, but Smartphones looks promising. Now, to know about the success of this kind of pervasive e-learning we have shown a 5 minute video sample from a course to a group of students using a Qtek Smartphone (figure 10) and afterwards then we have evaluated their knowledge on the subject with five questions about the subject.

Fig. 10. Receiving the webcast on a Smartphone

The screen of our Smartphone is just 2.8 inches with QVGA screen size and we think that it is a good trial platform for our application because of its small size. As shown on table 2, users follow properly the proposed course and pervasive video e-learning can be considered as a very useful technique.

	Scoring (5 Perfect, 0 Bad)
User 1	3
User 2	5
User 3	5
User 4	4
User 5	4
User 6	5
Average	4,33

Table 2. Average score

4. Effectiveness of video screencasts

We have much data about video screencasts usage at the Polytechnic University of Valencia. We will insight into that data and will obtain metrics and results from it.
In order to get evidence of usefulness for Polimedia we have focused on two indicators, the overall usage of all Polimedia content, and a course taught in two simultaneous instances, one with Polimedia and one with a live teacher.
For the first one, as can be seen in figure 11, Polimedia usage is constantly increasing, especially from the beginning of this academic course. We believe in this indicator as reference from both the student and the teacher side.

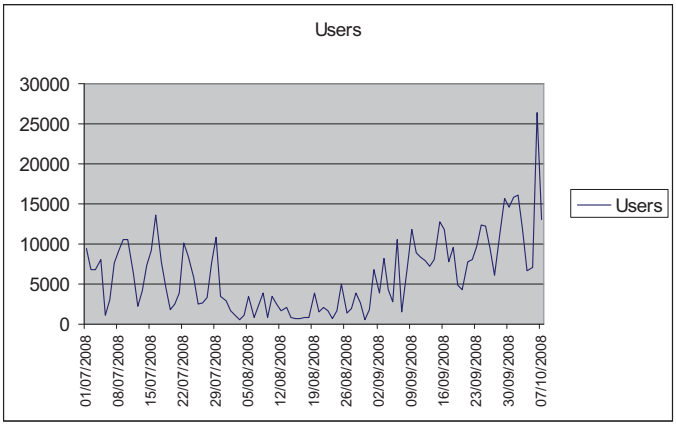

Fig. 11. Polimedia usage

For the second one, we gave a Microsoft Excel course between November and December 2008 to a group of students with the same teacher, syllabus and overall duration (with Polimedia you can replay teacher's explanation as you wish). Results for this experience are very similar in both cases, even having a little preference for Polimedia, as can be seen on Table 3.

	Classical learning	Blended learning with Polimedia
I have reached knowledge objective for this course	90%	90%
Course lenght is appropiate for Course content	85%	90%
Teacher's course can be considered as a good teacher	95%	95%
I wish I would have more presential sessions	N/A	25%
My expectations for this course have been satisfied	80%	85%

Table 3. Efectiveness of video screencasts

5. Conclusion

In this chapter we have presented the techniques of screencasting, webcasting and video screencasting in the field of e-learning. Following that we have had an insight on the video screencasting technique, both for networked PCs and for mobile hone and smartphones. Finally we have evaluated the video screencasting technique with very successful results.

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E-learning

Edited by Maja Jakobovic

ISBN 978-953-7619-95-4
Hard cover, 312 pages
Publisher InTech
Published online 01, February, 2010
Published in print edition February, 2010

E-Learning is a vast and complex research topic that poses many challenges in every aspect: educational and pedagogical strategies and techniques and the tools for achieving them; usability, accessibility and user interface design; knowledge sharing and collaborative environments; technologies, architectures, and protocols; user activity monitoring, assessment and evaluation; experiences, case studies and more. This book's authors come from all over the world; their ideas, studies, findings and experiences are a valuable contribution to enriching our knowledge in the field of eLearning. The book is divided into three sections. The first covers architectures and environments for eLearning, while the second part presents research on user interaction and technologies for building usable eLearning environments, which are the basis for realizing educational and pedagogical aims, and the final last part illustrates applications, laboratories, and experiences.

How to reference

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Carlos Turro, Luis Morcillo and Jaime Busquets (2010). Developing Screencasts and Video Screencasts for E-learning, E-learning, Maja Jakobovic (Ed.), ISBN: 978-953-7619-95-4, InTech, Available from: http://www.intechopen.com/books/e-learning/developing-screencasts-and-video-screencasts-for-e-learning

INTECH
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InTech Europe
University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China
Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821