On webcasting to mobile devices: reusing web & video content for pervasive e-learning

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Abstract—One of the biggest concerns in e-learning is the development of suitable content. To reuse standard webcast content for mobile phones and smartphones we have designed and tested a content adaptation system that enables the presentation & reuse of webcast multimedia content for resource limited mobile terminals. In particular, our system approach the limitations related to small screen displays.

The presented system has been integrated and tested in real terminals using diverse bitrates and resolutions, and we have carried out a subjective evaluation of its capabilities through a group of students.

Index Terms—Learning systems, Mobile phones.

I. INTRODUCTION. RELATED WORK

In the e-learning field, webcasting is related on the use of the Internet to broadcast live or delayed audio and/or video transmissions, much like traditional television and radio broadcasts. For example, a university may offer on-line courses in which the instructor webcasts a pre-recorded or live lecture. Users typically use a web browser or a specific multimedia application in order to view a webcast. Initiatives like MIT OpenCourseWare [1] have put many learning courses freely available on Internet using this basic webcast style.

Using a more structured style, webcasting applications, like MS Producer [2] or Adobe Connect [3] 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. Currently we have more than 80 hours of media content in webcasting format.

On the other hand, content for mobile devices uses 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 [4] proposed an expert system to segment video webcast content. Our system applies similar ideas specifically for mobile devices.

This paper is organized as follows. In Section 2 we will present the properties of the content we want to reuse Section 3 will describe the system we have used to repackage media content and section 4 will be devoted to experimental results. Finally section 5 points out some conclusions about the system.

II. PROPERTIES OF WEBCAST CONTENT

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.

Another screen distribution, which we use in our own webcasting application, called Polimedia [6], 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 2). 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.
In order to produce contents for our platform we use a small TV production set. There, we record two synchronized video sources, from teacher and from slides. Those sources are combined as shown previously to be broadcasted or recorded for future use.

Finally, just mention that delivery of content is done through a web page that synchronizes two video streams through mms streaming. To allow structuring of media content we recommend teachers to split their content into smaller units “media bits” that can be viewed linearly or in other order depending on students’ necessities.

III. TRANSFORMING CONTENT FOR MOBILE DEVICES

Enabling the access and the presentation of multimedia content on limited environments represents a real challenge in current mobile environments. Mobile devices platforms are subject to several and various constraints which make the design of adaptable multimedia architectures significantly complex. So, without advanced adaptation techniques, these languages fail to provide functions that take into account client’s limitations. This limitation is addressed in adaptation systems which apply structural transformations using transformation languages such as XSLT [7] and media objects adaptation such as video and images transcoding [8].

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 3.

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 4, on the left with full body, on the left with half body and the same on the right side.

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 5. 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’s incorrectly seen at slide channel.
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.

<table>
<thead>
<tr>
<th>Region</th>
<th>% use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28%</td>
</tr>
<tr>
<td>2</td>
<td>42%</td>
</tr>
<tr>
<td>3</td>
<td>4%</td>
</tr>
<tr>
<td>4</td>
<td>10%</td>
</tr>
<tr>
<td>5 (none)</td>
<td>16%</td>
</tr>
</tbody>
</table>

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.

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 6, 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.

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 7) and afterwards then we have evaluated their knowledge on the subject with five questions about the subject.
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 II, users follow properly the proposed course and pervasive video e-learning can be considered as a very useful technique.

<table>
<thead>
<tr>
<th>Scoring (5 Perfect, 0 Bad)</th>
</tr>
</thead>
<tbody>
<tr>
<td>User 1</td>
</tr>
<tr>
<td>User 2</td>
</tr>
<tr>
<td>User 3</td>
</tr>
<tr>
<td>User 4</td>
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<tr>
<td>User 5</td>
</tr>
<tr>
<td>User 6</td>
</tr>
<tr>
<td>Average</td>
</tr>
</tbody>
</table>

Table II. Average Score

V. CONCLUSION

In this paper, we have presented an experimental content adaptation system that enables the presentation & reuse of webcast multimedia content for resource limited mobile terminals. In particular, the system approach the limitations related to small screen displays.

The presented system has been integrated and tested in real terminals using diverse bitrates and resolutions, and we have carried out a subjective evaluation of its capabilities through a group of students.

This system has been tuned successfully to obtain a resolution of 320x240 or 176x208 at 15 fps frame rate and 256 Kbps throughput, which we have been able to stream to Smartphones and mobile phones. Also we have been able to reuse standard webcast content for Smartphones, although not all the content can be reused on mobile phones.

REFERENCES