# Design, Development and Evaluation of a Portable Recording System to Capture Dynamic Presentations Using the Teacher´s Tablet PC

Enrique Barra, Abel Carril, Aldo Gordillo, Joaquín Salvachúa, Juan Quemada

*Abstract*—Computers and multimedia equipment have improved a lot in the last years. They have reduced their cost and size while at the same time increased their capabilities. These improvements allowed us to design and implement a portable recording system that also integrates the teacher´s tablet PC to capture what he/she writes on the slides and all that happens in it. This paper explains this system in detail and the validation of the recordings that we did after using it to record all the lectures the "Communications Software" course in our university. The results show that pupils used the recordings for different purposes and consider them useful for a variety of things, especially after missing a lecture.

*Keywords*—Recording System, capture dynamic presentations, lecture recording.

## I. INTRODUCTION

THERE have been extensive developments in the way presentation tools are being used in lectures. Different software tools have been developed from scratch to try to enhance the presentation tools [1], [2]. This approach requires high budget, because the development costs of complex software products is very high, and implication of teachers and faculty members, because they should stop using the presentation tools they are used to and switch to the new one.

Otherwise, these "traditional" presentation tools, such as Microsoft Power Point or Apple Keynote, or new popular ones, such as Prezi [3], also offer a good opportunity to increase the students interest in the topics explained [4].

Writing directly on the slides as if they were a blackboard is very useful in some scenarios [5]. Some presentation tools have integrated this option, but one of the best approaches is to use a tablet PC and a stylus. This solution is becoming very popular in some universities and courses [6].

On the other hand old classroom recording systems are not able to introduce these improvements directly in the recording. They are also usually fixed [7], having to move the location of the class to the recording room or having to repeat the lecture without the students to make the recording.

To address these problems and enhance the recording system we already had, we have taken advantage of the possibilities offered by the new technologies. Electronic equipment is reducing its size, its cost and increasing its

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capabilities, like High Definition (HD) recording. HTML5 standard [8] allows videos to be multi-device, achieving a broader diffusion and use. With the introduction of these improvements we made our recording system portable, able to introduce the teacher´s tablet device and what he/she writes on the slides and affordable at the same time.

The rest of the paper is organized as follows. The next section reviews the related work in the area of lecture recording systems. Section III describes the scenario that brought up the opportunity to improve the system. Section IV explains the system in detail in such a way that it can be reproduced in other scenarios. Sections V and VI show the results of a survey conducted with the students and discuss about them. Section VII finalizes with some conclusions and an outlook on future work.

## II. RELATED WORK

There are many studies that demonstrate the usefulness of lecture recordings in many learning scenarios. In [9] 94.9% of the 1140 students that filled in the survey for the study agreed or strongly agreed that the video recorded lectures are useful in relation to their studies in the university.

Another survey was conducted in [10], where 517 students answered it indicating that the recorded lectures were useful for:

- Preparing for the exam (96.9%)
- Making up for a missed lecture (90.0%)
- Improving retention of lecture materials (91.1%)

On the other hand another very interesting study was performed to understand the demand, direction and best practices of lecture capture services at several institutions [11]. 150 representatives from different institutions in thirteen countries answered the survey. Most of these people work is related with the lecture recording field, like technology in education experts or audiovisuals experts. 79% of them answered that their university was providing lecture capture services in any of its classrooms, 78% from the remaining that did not have lecture capture said that there was a plan to add this capability in the near future, and only 22% answered that there was not a plan. From the ones that had a lecture capture service only 31% captured audio, video and additional sources, such as a computer or document camera. The rest of the systems (69%) captured only audio, audio and video or audio with additional sources. Finally 61% had no access to a portable recording system, and 18% only had access to one portable recording system.

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The first studies commented confirm that the usefulness of the lecture recordings use is very high. But the last study shows that most of the institutions have a lecture recording system or plan to install it but this system in use are not good enough.

This is why lecture recordings systems research field is very active. We can find commercial tools, like the one from Epiphan [12] or the one from Echo360 [13], but also research studies that develop systems from scratch. Examples of those can be E-chalk that recognizes handwriting in whiteboards and is very useful for complex use-cases like students interacting with the teacher presentation with their tablet PCs.

Virt Presenter [14] introduces the concept of hypermedia navigation in the resulting video and content preview. However it requires a lot of equipment and post-processing.

In [15] the authors present a system very similar to the one presented in this paper. It allows handwriting directly on the slides while at the same time they capture and record everything. Although it is not portable, only uses PDF files and instead of the teacher´s tablet PC they require a USB writing tablet.

Finally there are many automatic lecture recording systems, such as [16] or [17], trying to avoid the presence of a technician in the room to support the recording system. The cameras follow the teacher automatically and the recording starts and stops automatically. But in the end the video always need some post-processing.

## III. SCENARIO

In our department at the Universidad Politécnica de Madrid (UPM) we had one classroom equipped with old fixed lecture recording systems installed. It was not very used because teachers prefer to stay in the corresponding room and not to move all the pupils to another room. Also as the system is quite old the recordings resulting quality is not as good as it is with a modern system.

We wanted to record all the lectures of a course with good quality. So we had to improve this system and we considered it a good opportunity to make it portable and to introduce the teacher tablet PC as some teachers are getting used to present their slides with this kind of devices.

So we designed and implemented the portable lecture recording system. This system has been used this year in a programming course at UPM called "Communications Software".

The course is compulsory for pupils of the fourth year of Telecommunications Engineering degree in the majoring of computer science. It has 60 lecture hours and 152 pupils enrolled this year.

The use of tablet PC and a stylus in programming courses is especially useful as the slides contain a lot of examples with lines of codes and snippets of programs. The teacher usually explains this code to the pupils and highlights important parts or writes alternatives on the slides.

## IV. PORTABLE RECORDING SYSTEM

In this section we will describe the system in detail in such a way that it can be reproduced in other scenarios. Fig. 1 shows a photograph of the full system and Fig. 2 shows the hardware schema with the connections.



Fig. 1 Portable recording system



Fig. 2 Hardware connections

In this system we use only one computer because it is powerful enough to capture all the signals and mix them in one video. We can see in Fig. 3 one recording where the teacher have written one sentence and highlighted several lines of code.
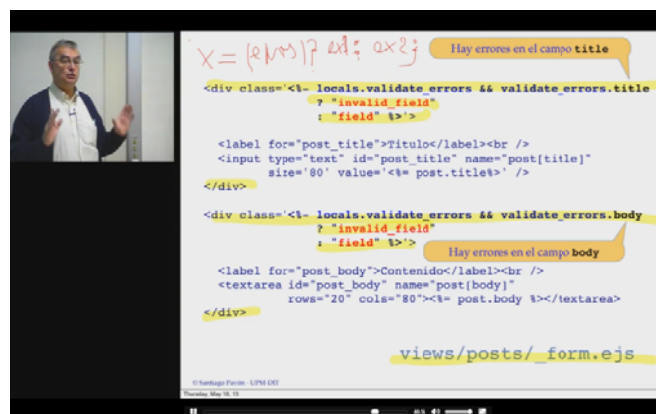


Fig. 3 Recording capture

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The desktop computer needs a video capture device (connected in the USB port) to connect with the camera, also a VGA video capture card (integrated) to capture the VGA signal from the tablet PC and an audio card to capture the audio from the wireless microphone. The audio card is standard as it comes with all the desktop computers but the other two have to be acquired separately. The splitter is needed to divide the VGA signal between the capture card and the beamer in the classroom.

Other components that do not appear in the hardware schema but can be seen in Fig. 1 are the table with wheels to make it portable and the tripod to hold the camera and easily move it.

The software that we use is XSplit (http://www.xsplit.com/). The license costs 50€. We have discovered recently an alternative that is free and open source; it is called Open Broadcaster (http://obsproject.com/).

The configuration of all the equipment in the Windows 7 or Windows 8 is very simple as all the drivers come with the equipment. Other interesting configuration is the capture software (XSplit or Open Broadcaster). We capture at 1366x768 resolution and keyframe every 2 seconds. The format is H-264. The resulting videos are about 400 MB per hour. So pupils will need about 100kbps bandwidth to receive them well. We also transformed the videos to webm format and flv to make them multi-device.

Recently Firefox has included H-264 codec, so in the future we will only need to transform the videos to flv format. This transformation is really quick as it only needs to change some headers in the video file and not recompress everything.

Finally Table I shows the prices for each of the components as they could be bought on 31/10/2013 at http://amazon.com. This is just one of the possible configurations with one example of each type of equipment. The minimum requirements for the computer are core i3 (or equivalent) and 2 GB of RAM, for the camera nothing special, just that it has composite output, we don´t use HDMI because it introduces 2 or 3 seconds delay in some models.

TABLE I
EQUIPMENT LIST AND COSTS

| Equipment | Model | Cost |
|---|---|---|
| Desktop computer | DELL Inspiron i660s-2313BK Intel core i3 – 4GB RAM (Comes with Windows 8) | 295€ |
| Monitor | ASUS VS207D-P | 77€ |
| Keyboard and mouse | Logitech MK120 | 10€ |
| VGA Video capture | Avermedia Game Broadcaster HD | 88€ |
| USB video capture | AVerMedia DVD EZMaker 7 | 26€ |
| Wireless Microphone | AKG WMS-40 Mini | 73€ |
| Camera | JVC GZ-E15BEU | 110€ |
| VGA Splitter | Startech2 ports VGA Splitter | 18€ |
| Tripod | Slik Sprint Mini II GM | 59€ |
| Cables | Minijack-jack, VGA, Composite | 60€ |
| Table with Wheels | | 65€ |
| XSplit license | | 50€ |
| **Total** | | **931€** |

## V. RESULTS

The system has been used to record all the lectures of the course "Communications Software". We have also evaluated the experience with a survey among the students, getting very good results. In this survey students were asked about the use that they did of the videos and the usefulness of these videos for different purposes. Finally they were asked about the use of the tablet and the stylus, what devices they used to watch the videos and the problems they had encountered in order to help us to improve the service.

94 pupils answered the anonymous survey. The results show that 20% (i.e. 19 pupils) viewed more than 90% of the videos, 22% (21) viewed about 75% of the videos, 32% (30) about 50% of the videos, 23% (22) about 25% and only 2% (2) did not view any video.

About the devices used by pupils 98% (92) used a desktop computer or laptop, 16% (15) tablet PC and 8% (8) used a smartphone. In this question they could mark more than one answer as they are not exclusive.

Figs. 4 to 6 show graphs with the aggregated results of several survey questions. We will discuss about them in the next section.

In the questions related to Figs. 4 and 6 pupils had to rate each sentence with a 6 point Likert scale [18], being 0 "not at all" and 5 "totally" in the question of Fig. 4 and 0 "not useful at all" and 5 "very useful" in question of Fig. 6.

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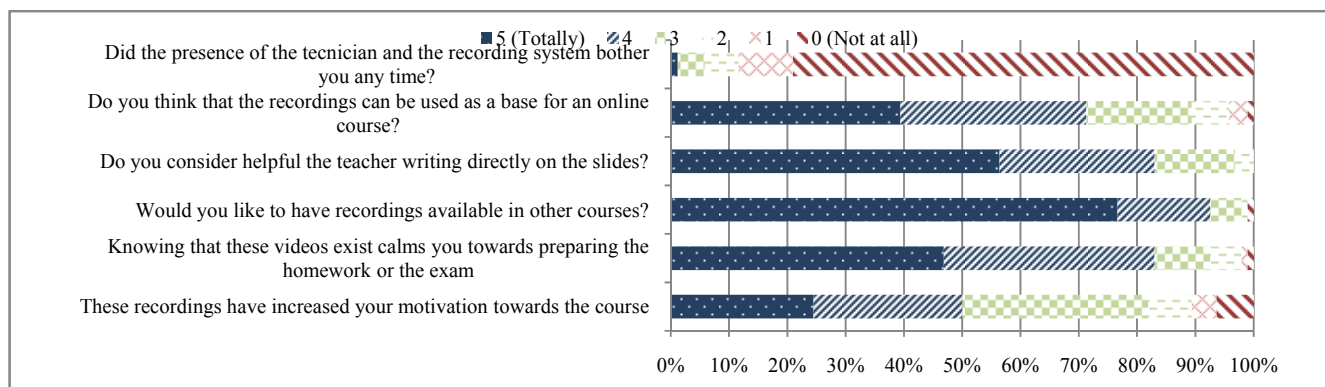Vol:8, No:3, 2014

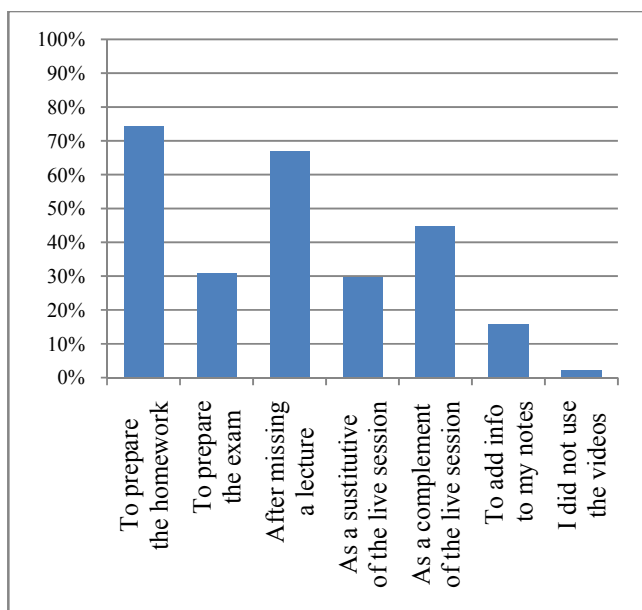Fig. 4 Results for "Rate the following sentences:"

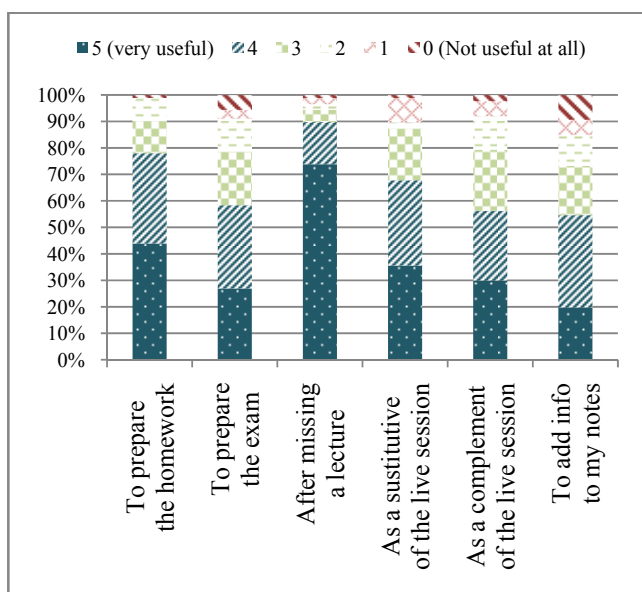Fig. 5 Results for question "what did you use the recordings for?"



Fig. 5 Result for question "what were the recordings useful for?"

In a last question we asked pupils about technical difficulties. 67% (63) of them answered that they did not have any technical problem. 13% (12) reported that the video sometimes stopped to buffer. 11% (10) reported that they had to change device or browser to see the videos. The remaining 9% (9) complained about the quality of the video, audio or that the text in the slides could not be read sometimes in the videos.

## VI. DISCUSSION

In the survey results presented in the previous section we can see that only 2 pupils did not use the videos, so the rest 92 have used the videos to a greater or lesser extent. The different pupils watched more or less videos because they used them for distinct purposes. If the pupil uses the videos after missing a lecture or to add information to the notes taken in the live session he/she will use only some videos, but if he uses it to prepare homework or exams he/she will use almost all videos.

The recording were mainly used to prepare the homework (74%) and after missing a lecture (67%). The course is about programming and the homework is quite difficult and requires a lot of attention in the live session. So these recordings are considered very useful for these tasks.

Regarding what the pupils consider the videos useful for, the first result is to recover a missing lecture, where 89.7% of the answers were for option 4 or 5 (i.e. very useful). The second result is to prepare the homework with 78% for those same options. This result matches with what pupils used the videos for.

In Fig. 4 we can see that the best rated sentence is "would you like to have recordings available in other courses?" where 92.5% of the answers were for options 4 or 5. Special attention here to "Do you consider helpful the teacher writing directly on the slides?" where 83% rated it with options 4 or 5.

Technical problems and issues reported by the pupils suppose a dilemma because some pupils complain about the video buffering sometimes so we should reduce its size to consume lower bandwidth, but others complain about audio or video quality or that they could not read the slides text in the videos so we should increase the quality. As a compromise what we can do is produce two versions of the videos, one for low bandwidth devices (such as smartphones and tablets),

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compressing it under 200MB per hour (approximately 45kbps are needed to view it without buffer) and one version for high bandwidth devices with 600 MB per hour (so 135kbps are needed to view it).

Overall, the recordings had a very good acceptance. The presence of the technician in the classroom did not bother the pupils and they used the videos frequently and for different purposes. About the equipment, its final cost is lower than 1000€, so it is affordable for most universities and educational institutions.

With regard to limitations, the main one with our system is that it requires the presence of a technician in the classroom. So although the system is quite cheap a technician is needed but even automated recording systems need a technical team to get the recordings from the system, cut unwanted parts (like the end or the beginning of the video), recompress the files and generate the embed codes to upload to the learning management system in the specific courses.

Although we have not done it with the course "Communications Software" it is very easy to do live streaming of the live sessions. We just have to configure it in XSplit or Open Broadcaster to feed your streaming server with the same signal that you are recording. Then we can share the streaming embed code with the pupils and we should enable a chat to enable questions from remote pupils following the live streaming session.

## VII. Conclusion & Future Work

In this paper we have presented a portable lecture recording system, able to introduce the teacher´s tablet PC signal in the recording and very affordable. We have detailed the hardware components and the software needed so it can be reproduced in any other scenario.

This system has been used in this year "Communications Software" programming course with very good results. We have also presented the results of the survey conducted among the pupils. They have used the videos for different purposes and consider them to be very useful for some of them, like to recover a missing lecture or to prepare the homework.

As immediate future work these videos will be used as the base for a HTML5 MOOC (Massive Open Online Course) that we are already preparing.

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