Work in Progress: Real-time Annotations of Video-lectures

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Abstract. We present our work about the development of a system, which allows taking notes during a lecture, and having the notes integrated in the video recording of the lecture itself. The notes become semantic markers into the video, and could possibly be shared with peers and teacher.

1 Introduction

The work we present is an attempt to put together several areas: capturing of lectures in the form of videos, annotation sharing and multimedia annotations.

Recording traditional lectures in the form of videos is a practice that dates back to the end of the nineties, and has been widely deployed in recent years (see [1, 2] for a review).

The idea of sharing annotations is not new: already in 1999 Davis et al. [3] discussed the possibility to allow group members easy access to each others experiences through their personal notes. The system allowed group members to share the notes they were taking through a shared repository. Robertson et al. [4] observed users behavior in three different scenarios: No Notes, Private Notes, and Shared Notes. A more learning-centered approach to note taking was developed by Miura et al. [5]. Their AirTransNote was an interactive learning system augmented by digital pens and PDAs for each student. Notes taken by the students were transmitted to teacher's PC to generate feedback. Miyake and Masukawa too [6] investigated a note-sharing scenario in a university setting.

Also the idea of annotating multimedia for learning purposes has been explored: see for instance Chu et al. [7].

Our work starts from a video-recording scenario, and enriches it with the possibility to take on-line notes (either during the actual lecture, or while watching the recorded lecture). These notes are attached to the video, and become a personal tool for marking relevant passages in the video itself, for later reference. Also, these notes can be shared with peers, and become part of lecture metadata, which can be deployed for learning analytics purposes.

In the following we shortly describe our scenario and how we achieve our goals before coming to discussion and conclusions.

2 Scenario and system description

We deal with a setting, in which lectures are (video) recorded and made available over the lecture shortly after their end. We assume here that lectures are mostly frontal, methodology that, in spite of being highly deprecated, is still the quite commonly encountered in academy.

The practice of recording lectures and making them available via web, either in open form or with protected access in a Learning Management System, is obviously useful for students who cannot attend classes. However, it has been demonstrated that even students who were in class use the videos to selectively review portions of lectures, for instance for checking their notes, clearing some doubts, resolving interpretation conflicts with their peers [8, 9]. In general, to identify the relevant portion in the recording, students can seek be using a time bar, but some video-recording systems also provide certain semantic markers such as indicator of slide transition, slide titles or text and/or slide thumbnails. We thought that some other types of markings could be generated, and devised a system that allows students to annotate the (video) lecture.

In our scenario, the teacher uploads on a web site some lecture notes before the beginning of the lecture. An example of such handout could be a PDF containing the slides that the teacher will use during the lecture. In absence of such resource, even a white PDF (representing a blank sketchpad) can be provided (it will be clear later why). Students are given access to the handouts in a browser, and a Single Page web Application (SPA) allows them to annotate their own (virtual) copy of the lecturer's notes in class, while the lecture is given. The SPA allows adding notes in the form of typed post-it-like sheets, by highlighting text and by free hand sketching. Fig. 1 shows the current aspect of the prototype.

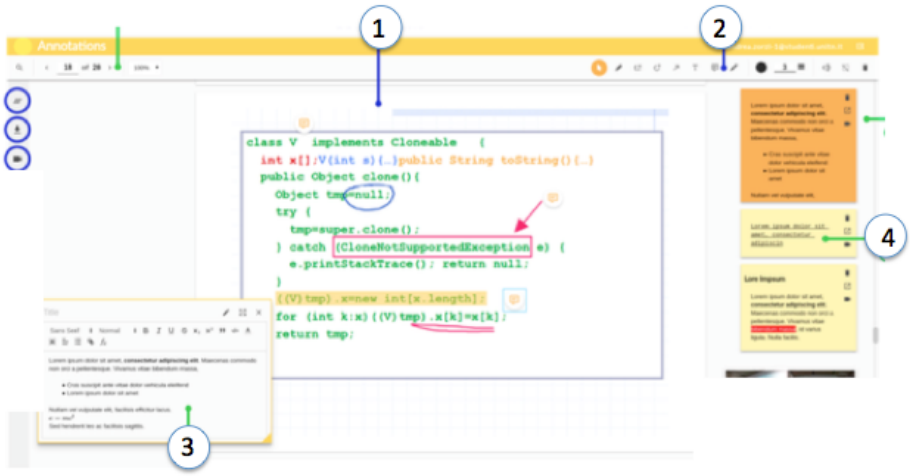

Fig. 1. Look of the prototype SPA for annotating the lecture in class.

In the figure, 1 indicates the current page of the PDF (in general it should coincide with what the teacher is projecting on the classroom); 2 is the menu from which stu-

dents can select the tool for annotating the PDF, 3 shows the area where a typed annotation takes place and 4 shows the already typed notes for the current page.

Free-hand writing is not very natural when using a mouse o a touchpad on a laptop, but is very effective when using a tablet. Hence, students using laptops will mostly type, while those using tablet will prevalently hand-write.

Student notes are saved in a database. Each student has a personalized view of her/his annotated handout, so that s/he only sees her/his own notes: access to the SPA is individualized via a login gate. Apart of the content and the reference to the user, the database also saves a timestamp, which records when the note was jotted.

At home, students use a second SPA, which allows viewing the recorded lecture together with the notes taken in class. Fig. 2 shows the second SPA.

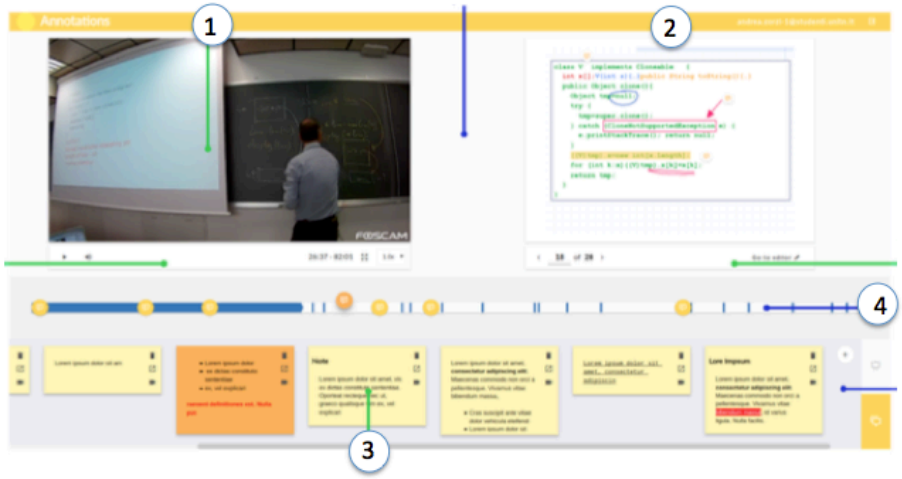

Fig. 2. Look of the prototype SPA for reviewing the lecture after class.

In the figure, 1 and 2 respectively show the video and the annotated slide. The system looks similar to many video-lecture playing tools, but here the slides contain the markings superimposed by the student. In fact, the time-bar (4) contains markers showing the time-location of the annotations, and the lower region (3) shows a (scrollable) series of notes so that students can quickly jump to a note (which lets the video jump at the time, when the note was taken.

Of course the synchronization of video and notes is allowed by the timestamps we saved in the database Hence the notes become a personal index for the video-lecture.

The system also supports a different type of scenario: a variant of the first SPA allows taking notes when watching a video-lecture. This covers the case, when a student not present in class at lecture time takes the lecture in its recorded form: still, s/he has the option of taking notes while watching the recorded lecture. In that case the system is able to detect that notes are taken in a deferred scenario, and not during the real lecture. The synchronization mechanism, aware if this fact, is able to mark the time stamp of the note as if it was taken in class, hence making notes taken in class

equivalent to those taken when watching the video. After that, the student is still able to review her/his notes together with the synchronized video using the second SPA.

All students' actions are monitored, so that learning analytics can be employed and students' behavior can be tracked for later analysis of their learning processes. Apart the note-taking activity, also recalling notes, watching videos and all the operation done in this case (such as pausing, stopping, jumping ahead or backward, or playing video at higher speed) are recorded.

An overview of the software architecture which is at the basis of our system has been presented elsewhere [10].

3 Discussion and conclusions

Our preliminary work makes it possible to allow students to take on-line notes while in class or when watching a recorded video-lecture, and automatically aligns these notes with the video-lecture itself.

An advantage offered by this system is that if, during the lecture, the student finds that a passage is unclear or difficult, s/he can quickly take a note and later use the note as a marker to position the video to the time, where the portion to be re-watched is.

Sometimes it also happens that one does not have the time to mark down all the things on would be interested in (e.g. there can be references to URLs which are long or difficult to transcribe): also in such case annotating the specific portion of the video where the information is given is useful. Later students can recall the relevant portion and retrieve the information which otherwise would have been lost.

Also, it may happen that one takes a note, but when reviewing it one does not remember the context, and hence the note itself loses part of its meaning. The synchronization of notes and video allows reconstructing the lost context.

Given such role played by the annotations, even taking them on a blank sketchpad (in absence of teacher's handout) has a value. Hence, in absence of a PDF pre-loaded by the teacher, students can still take notes on such virtual sketchpad, with the advantage that these notes are synchronized with the video.

Yet another dimension is the social one: students could share notes with all their peers, or only with a group they belong to, or with (e.g.) their Facebook friends.

At the time of the writing of the present paper, a prototype of the system has been created and deployed. Experimentation has started, for the moment only with four pilot users: each of them uses a different client, so as to test the system is various environment. The test is being performed with two different laptops (an Apple Macintosh and a MS Windows 10 machine) and two different tablets (an Apple iPad and an Android tablet), to check for possible problems when using different machines (although the SPAs run into a browser, and hence should not be affected by operating system nuisances) and to verify the user-friendliness with two different device classes (laptop vs. tablet). The social aspects, although made possible by our software architecture, have not yet been investigated. Our work is in progress, so we are planning to have soon a more extensive and comprehensive validation.

The small-scale experimentation with real students showed that (in spite of some glitches due to the immature user interface) the idea is valuable and interesting to them. A possible but hitherto unexplored potential is the possibility of sharing the notes among the students, so we do not know yet how much this will be considered useful by them: this is the subject of a study we just started. As we mentioned, the system fully traces the students' actions, both when taking notes and when watching videos. This generates a wealth of data, which will be used for learning analytics. The density of notes, for instance, will be an indicator that teachers can use to monitor either the interestingness or the difficulty of certain passages in the lecture, and hence will become a tool for improving their teaching. The design of the logs still has to be refined, so as to allow extracting the maximum possible information out of them. Also this part of the study is presently in progress.
Videos could be used in a flipped classroom scenario, as suggested in [11]. In such case, students would use the version of the first SPA, which allows taking notes while watching the videos. In such scenario, notes taken by the students will contribute to the preparation of the following in-class phase. For instance, by formally asking students to mark the lecture points where they have troubles in understanding, or to add questions in-place in the lecture, the teacher will have rich material for the preparation of such phase. Also, the logs, which indicate for instance that the students re-watched certain portions of the videos, will be indicators of difficulties to which the teacher can later respond in class.

In summary, although the work we report here is only at a preliminary phase, we envision a set of interesting research areas that we intend to pursue in the near future.

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