DragonFly: Spatial Navigation for Lecture Videos

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Abstract
DragonFly is an application designed for reviewing lecture recordings of mind map-structured presentations. Instead of using a timeline slider, the lecture recording is controlled by selecting elements located at different positions on the map. Hence, video time is controlled by navigating in space.

A controlled experiment revealed that DragonFly reviewers performed 1.5 times faster in finding a specific scene of a lecture recording compared to reviewers that worked with QuickTime Player and a mind map printout.

Keywords
e-learning, lecture video, mind map, presentation software, review, spatial navigation, zoomable user interface

ACM Classification Keywords
H.5.2 Information Interfaces and Presentation: User Interfaces — Graphical user interfaces (GUI), User-centered design

General Terms
Design, Experimentation, Human Factors

Introduction

Among students, lecture recordings have become increasingly popular since they echo the experience of the live presentation [5,8]. For the student, lecture recordings provide several benefits [10]:

1. The student can determine the lecturer's pace.
2. The student is independent from lecture times and locations.
3. Recordings support studying for projects, exercises, and exams.
4. Students feel positive impact on their studies.

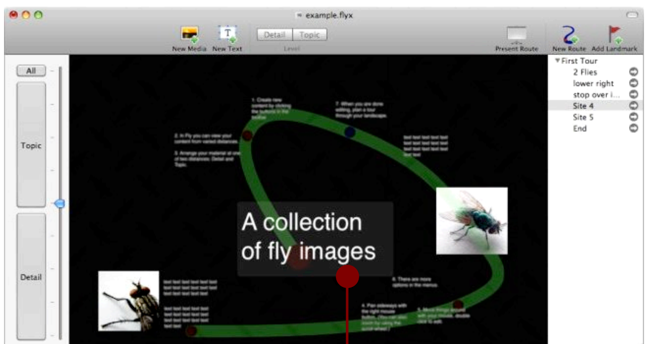

Figure 1. Fly: A tool to author planar presentations.

The presentation document represents a mind map.
Text elements and images, also called nodes, determine the content. A presentation path (green) is defined by a sequence of different camera views of the map.

Generally, students consider this medium as **supplementary material** and still visit the live lecture [2]. Hence, students roughly know what the recording is about and want to directly access smaller scenes of the video instead of watching it continuously from the beginning [4].

Software players generally feature scrolling with live visual feedback, which allows direct access to any scene in the (lecture) video. Some, such as QuickTime Player, also support slowing down or speeding up the video to further match a student's learning pace. However, such a control is **generic**, i.e., it navigates the video independently from its content. Searching for a scene where the lecturer explained a specific topic becomes an iterative, time-consuming, and hence annoying task. Special review applications (see "Related Work") tackle this problem for slide-based presentations. A click on a slide synchronizes the video accordingly. Yet, if the lecturer referred to one slide multiple times, these references are **scattered** across a timeline. Thus, the student has to skim through the timeline to find all references.

DragonFly

The idea behind DragonFly is different. Facilitating the navigation of the recording already begins with the live presentation. DragonFly enables reviewing of **mind map-structured presentations** authored with **Fly** (Fig. 1), a tool to author planar presentations [7]. The student uses the original presentation document as navigation control. A click on a location on the map forwards the lecture recording to the time the presenter discussed the selected item. If the lecturer referred to this item multiple times, the student can choose between different time references **at a glance**. This keeps the interface tidy, and **coherent references** are *not* scattered across a timeline.

Related Work

Direct video manipulation tools such as DimP and DRAGON [3,6] allow dragging of objects along their trajectories to forward the video. However, most lecture videos are rather static, and the student is not interested in the movement of objects but rather in finding particular slides and their verbal explanation.

Slideware-based Solutions

For slideware-based presentations, eClass [2], ePresence [1] and virtPresenter [9] feature a content-related navigation for lecture videos.

The first application works for presentations based on hand-written slides using an electronic whiteboard. **eClass** loads the slide material next to the video. The

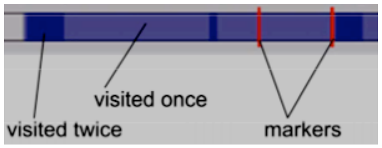

Figure 2. The virtPresenter timeline.

The darker the color, the more often a part has been watched by the students.

medium can be navigated by clicking on each word of the slide material; the software forwards the recording to the time the presenter wrote that word on the whiteboard. In practice, however, the matching is **asynchronous**, as a lecturer tends to verbally explain a topic before writing it on the board. For **ePresence**, **slide-based navigation** synchronizes the video using time stamps: Clicking on a title out of a list forwards the recording to the time when the presenter introduced the corresponding slide. Slide-based navigation also works for **virtPresenter**. Besides, this application offers **social navigation**. It tracks each user's access to the video, i.e., which sequences have been watched. Intensively watched parts are then visualized on a timeline such that other reviewers can access these parts directly (Fig. 2). Yet, this kind of navigation is only useful if many students have watched the video before, as the system must track data.

Initial Survey

Before planning the design of DragonFly, I conducted a survey to understand what problems people have when working with lecture recordings. A total of 87 students and former students were either interviewed personally (12) or filled out an online form (75). They were aged 20 to 40, 77% were male. About 43% had already used lecture videos (group A), the others had not (group B). Almost 61% of group A clearly **refused using a slider** because it did not allow a content-related navigation. On the contrary, 65% of those who have never worked with lecture videos before considered a slider a useful tool. Evidently, experience appears to teach that a slider is an inappropriate tool for controlling a lecture recording. For that reason, DragonFly uses a slider only as a secondary control and instead focuses on navigation *of* the content *through* the content itself.

Navigation of Time via Space

Fly presentations are conceptually different from slide-based presentations. Instead of showing a linear sequence of isolated frames, Fly works with the mind map metaphor. Text snippets and images, so-called **nodes**, can be placed on a virtually unlimited plane at two different levels of height. The author defines a presentation path by marking "**stops**" of different locations on the map at arbitrary zoom level. During presentation mode, the camera view on the map changes over time by "flying" along the defined path. Each location can be mapped to one time span or even more if a stop is presented multiple times.

As a slider is not a satisfying solution to control a lecture recording, DragonFly uses space to control the media. The student navigates[1] via a representation of the video content: the "Fly map" itself.

Design of DragonFly

While Fly is designed to present a talk with the aid of a zoomable mind map, DragonFly is meant for reviewing such a presentation using the document and the corresponding lecture video. Like Fly, DragonFly runs under Mac OS X 10.5. During the presentation, Fly stores **time stamps** indicating at which time which camera view of the map was being presented. Whenever the lecturer moves over to a new stop or selects a text snippet or image during the presentation, a time stamp is automatically created.

By opening the presentation file in DragonFly, the document is shown and the corresponding lecture video is loaded next to it (Fig. 3). In this context, DragonFly supports two directions of synchronization.

[1] Visit hci.rwth-aachen.de/~corsten/DragonFly/DragonFly.m4v to see the navigation concept in action.

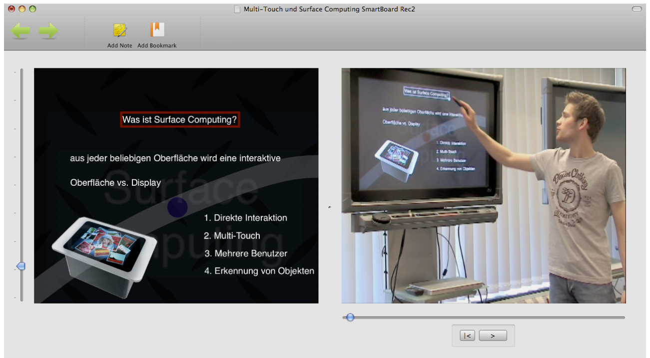

Figure 3. The DragonFly user interface.

The video (right) and the presentation document (left) are loaded next to each other. During playback, the content of the map and the video are synchronized. A red frame indicates what the presenter is currently talking about.

Figure 4. A segmented circle.

The image behind the circle has been referenced four times in the talk. The blue segment lasts longer than all the others.

Document-to-video Synchronization (DVS)
Concerning DVS, it is the user who navigates the video by interacting with the map, i.e., via **content-related spatial navigation** (CRSN). Whenever the student clicks on a stop in the map, the video is synchronized to the time the presenter started talking about the selected topic. Clicking on a node has an analogous effect. Hence, DragonFly is equipped with **fine**- and **coarse**-grained navigation.

CRSN also works if the presenter referred to an item multiple times (and thus to the same location). In a reviewing session, the user can choose between the different time stamps via a **segmented circle** (Fig. 4) that is faded-in. Each segment refers to a single time stamp, whereas its angle relatively displays the duration of the stamp compared to the others. If a segment has been selected, it is incrementally being filled for the time the time stamp lasts in order to provide visual feedback. Finally, the segment vanishes. The circles help to keep coherent references together at the same location. Zooming in and out or freely moving to any location on the map enables the student to explore the document without triggering synchronization.

Video-to-document Synchronization (VDS)
Helping the user to stay in track with the presentation flow is done via VDS. Whenever the presenter moved over to a new stop in the video and the current camera view of the map is not consistent with the content of the video frame, the map is automatically scrolled to the topic the video is showing. Besides, for all time-stamped texts and images, a red frame **highlights** the currently discussed item in the document, which is especially helpful for reviewers of audio-only media.

Besides, DragonFly **minimizes post-production**, i.e., the video footage does not need any editing. DragonFly only plays the actual presentation time span back.

Controlled Experiment

After the first design and implementation iteration of DragonFly, a controlled experiment with two user groups was conducted. Its goal was to verify the following hypothesis:

For a reviewer who has attended a live lecture, it takes less time to navigate to a searched-for scene of the corresponding recording using DragonFly compared to Apple QuickTime Player.

The experiment was inspired by the following ***scenario****:*

Bob is a second-year student of Medicine. At the moment he is working on an assignment about the "areas of Brocas" region. However, he cannot remember its functionality. What he does remember is that this topic has been covered by last week's lecture. In order to retrieve the needed information, Bob downloads the latest lecture video and its presentation file. In DragonFly, Bob scrolls the map for a stop entitled "Brocas area" and clicks a text item called "functionality". Now the video starts playing at the position Bob was searching for. Finally, he can complete his exercise.

Setup

A total of **14 subjects** participated in this study (age: 21-27, 1 female). The experiment consisted of two sessions. First, I held a 20-minute live talk in front of the participants on the topic of "Multi-touch and Surface Computing". As presentation software I used Fly. A SmartBoard[2] served as both projection display and input source that allowed comfortably creating time stamps by touching on elements of the map. One week later, the subjects were split into two groups of equal size, where each user individually tested a reviewing software herself.

The participants were given five questions about the lecture. Their task was to find the five different video scenes that answered the questions. Group 1 used QuickTime Player 7 and printouts of the mind map for orientation. Group 2 tested DragonFly that by default showed the Fly map next to the video. Since DragonFly was unknown to all testers of group 2, they were given five minutes to explore the application.

Results and Discussion

On average, DragonFly users **needed only 50%** of the time in retrieving the appropriate video scenes compared to QuickTime Player testers (Table 1). However, the results for the first two questions are not statistically significant, which may be due to additional familiarization needed by the testers. For the last question, the difference of the results between group 1 and 2 is also not significant because QuickTime Player reviewers had traversed the video four times such that they could easier estimate where the answer could be found in the video (a learning effect).

[2] www.smarttech.com

The answer to the third question was presented at a stop that had been discussed twice, but only the second reference revealed the information needed. DragonFly users clearly had an advantage because they could stay at the same location in the map, but select between the two different time references. QuickTime Player users had to drag the slider to different positions in an iterative process that took them additional time. The results of this question were statistically highly significant ($p < 0.01$) which shows that multi-referenced topics can be found easier and faster using DragonFly.

Feedback

Both groups were asked separately to rate how useful their applications were for retrieving information from lecture recordings. DragonFly users considered their navigation technique more useful (rated 1.29) compared to QuickTime Player testers who rated the generic tools with 1.86 (on a scale from 1 = "excellent" to 4 = "useless"). QuickTime Player was considered easier to use for generally watching a video, but its controls were regarded as inappropriate for reviewing lecture recordings. Although DragonFly is equipped with a timeline slider to control the recording besides interacting with the map, the slider was hardly ever used among participants of group 2.

Summary

In this paper, I presented DragonFly, a software featuring **content-related spatial navigation** for recorded lectures authored with **Fly** [7], a planar presentation tool. In DragonFly, the student navigates the recording with the aid of the presentation document, a **zoomable mind map**, instead of a

	Question 1		Question 2		Question 3		Question 4		Question 5	
Group	t[s]	σ	t[s]	σ	t[s]	σ	t[s]	σ	t[s]	σ
1	55.14	45.98	75.71	27.34	130.1	35.04	75.14	34.55	57.57	22.93
2	36.29	3.20	62.43	67.78	70.71	25.00	38.14	7.69	40.71	33.89
p-val.	0.3004		0.6392		**0.0033**		**0.0171**		0.2971	

Table 1. Results of the user test.

The table lists the average times the testers needed to find the demanded scenes for each question. On average, DragonFly users needed only 50% of the time QuickTime Player testers needed. For question 3 (a multi-reference question), the results are statistically highly significant. Unpaired t-test, df=12.

generic timeline slider A click on text snippets or images on the map forwards the video to the time when the presenter explained these topics. Navigation granularity comes at two different levels for **coarse** and **finer** steps. Multiple references for the same topic are kept together and made accessible by **segmented circles**.

A controlled experiment confirmed that reviewers neglect using the generic slider and prefer working with controls tailored to content of the respective lecture. Compared to reviewing with QuickTime Player and a set of printed slides, DragonFly users performed more than **1.5 times faster** in retrieving specific lecture scenes.

Future Work

Looking at the experimental results, DragonFly needs some further usability improvements. For example, the automated movement of the map triggered by VDS irritated some users. DragonFly should therefore let the user decide to enable this feature or not. Besides, some testers asked for **direct manipulation**. Two of them even tried to interact with the video. They hoped that clicking on a text item that was visible in the current video frame would forward the recording, as does the map. In this context, DragonFly could combine the power of free movement in the map with direct manipulation just by using the recording as interaction medium. Finally, an **iPhone version of DragonFly** could greatly improve the mobile lecture reviewing experience. Due to limited screen size, the combination of map interaction and direct manipulation would make much sense in this domain.

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