RWTH AACHEN UNIVERSITY

DragonFly

Reviewing Lecture Recordings with Spatial Navigation

Bachelor's Thesis at the
Media Computing Group
Prof. Dr. Jan Borchers
Computer Science Department
RWTH Aachen University

by
Christian Corsten

Thesis advisor:
Prof. Dr. Jan Borchers

Second examiner:
Prof. Dr. Ulrik Schroeder

Registration date: July 03rd, 2009
Submission date: Oct 07th, 2009

I hereby declare that I have created this work completely on my own and used no other sources or tools than the ones listed, and that I have marked any citations accordingly.

Hiermit versichere ich, dass ich die vorliegende Arbeit selbständig verfasst und keine anderen als die angegebenen Quellen und Hilfsmittel benutzt sowie Zitate kenntlich gemacht habe.

Aachen, October 2009
Christian Corsten

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Abstract

Lecture recordings and their playing have become an active field of research since the mid 90s. Current systems that allow reviewing the presentation material synchronised with its recording refer to the slide metaphor. Control is often restricted to timeline sliders, standard video navigation buttons or linear lists that allow direct access to the beginning of each slide in the video.
In my thesis, I present DragonFly, an application designed for reviewing lectures based on mind map-fashioned presentations. Navigation is done with the presentation document. The use of a timeline slider is secondary as the reviewer uses spatial navigation to target at a searched-for topic on the map. Consequently, the video is forwarded to the time the presenter introduced the selected theme.

An initial survey revealed necessary design decisions for DragonFly. Confirmed by a final user study, DragonFly users perform faster in retrieving searched-for lecture recording scenes compared to reviewers using a standard player such as QuickTime Player in combination with printouts.

Überblick

Vorlesungsaufzeichnungen und deren Wiedergabe sind seit Mitte der neunziger Jahre in das Interesse der Forscher gerückt. Verfügbare Systeme, die die Betrachtung der Aufnahmen mit synchronisiertem Präsentationsmaterial ermöglichen, stützen sich dabei auf folienbasierte Präsentationssoftware. Die Navigation innerhalb der aufgezeichneten Vorlesung ist mittles Zeitschiene und Schieber, gewöhnlichen Video-Bedienelementen oder Listen möglich. Letztere erlauben den direkten Zugriff auf den Beginn jeder einzelnen Folie im Video.
In meiner Arbeit stelle ich eine Anwendung mit dem Namen DragonFly vor, welche das Nacharbeiten von Vorlesungen ermöglicht, die sich auf Mindmap-ähnlichem Präsentationsmaterial stützen. Die Navigation findet im Dokument statt. Die Verwendung eines Zeitschiebers ist dabei zweitrangig, da der Betrachter eine räumliche Navigation verwendet, um gesuchte Themen in der Mindmap anzupeilen. Das Video wird folglich zu der Stelle vorgespult, an der der Vortragende das gewählte Thema vorgestellt hat.

Eine einführende Umfrage zeigte dabei notwendige Entwicklungsrichtlinien für DragonFly auf. Anhand einer abschließenden Benutzerstudie konnte bestätigt werden, dass die Nutzer von DragonFly schneller gesuchte Szenen aus der Vorlesungsaufzeichnung finden als die Betrachter, die eine gewöhnliche Abspielsoftware, wie z.B. QuickTime Player in Kombination mit ausgedruckten Folien, verwenden.

Acknowledgements

First of all, I would like to thank all testers who participated in the user study for DragonFly. Thank you for your constructive feedback and the time spent in both sessions.

Secondly, I thank all people who took part in the initial survey.

Special thanks go out to my supervisors Leonhard Lichtschlag and Moritz Wittenhagen for their feedback, support and advice for my thesis.

In addition, I thank the staff from the "Lehr- und Forschungsgebiet 9" (LuFG 9) of RWTH Aachen University for their feedback on DragonFly.

Finally, I want to thank Dieter Drobny for giving me instructions to the camera I needed for my user study.

Conventions

Throughout this thesis I use the following conventions.

Definitions or short excursus are set off in coloured boxes.

EXCURSUS:
Excursus are detailed discussions of a particular point in a book, usually in an appendix, or digressions in a written text.

Definition: *Excursus*

The whole thesis is written in British English.

For reasons of politeness, unidentified third persons are described in female form.

Chapter 1

Introduction

Reviewing a lecture is a task done by almost every student. As a human's concentration and retentiveness decreases as time goes by or people forget what they have learned before [Dix et al., 2004], reviewing is an indispensable manner to confirm attained knowledge.

Almost every student reviews lectures.

Concerning lectures, there exist different ways of recapitulating the subject matter presented. Reading books, browsing the web, asking fellow students or skimming through the slides are a few common methods.

1.1 Reviewing Lectures with Recordings

Since the mid 90s lecture recordings, i.e., audio- and videotaped presentations, have become more and more popular [Hürst and Götz, 2004]. The idea is to echo the experience of the live presentation. Thanks to increasing bandwidth of the internet, videotaped lectures can be streamed or downloaded from home, like content supplied by Apple's iTunes U[1] (cf. Figure 1.1).

Lecture recordings are becoming a popular media for reviewing.

As reviewers are confronted with new facts that they need to process, reviewing a lecture is a demanding task. It is therefore important to minimise cognitive load for controlling the recording and to make navigation more

[1]http://deimos3.apple.com/indigo/main/main.html?v0=WWW-AMUS-ITUNESU070521-N48LX

Figure 1.1: iTunes U. iTunes U offers a wide variety of lecture recordings, such as eLearning lectures recorded at RWTH Aachen University. These videos can be downloaded from the iTunes Store for free.

Using a slider for controlling the lecture video is uncomfortable.

comfortable. Retrieving specific parts of this type of video is the main interest of reviewers [Hürst, 2002]. Using a standard software video player is dissatisfying as a content-oriented navigation is not supported. Controls used in such players — such as a time line slider, a forwarding and a rewinding button (cf. Figure 2.3) — are universal, i.e., they navigate 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 for the reviewer.

Special playback software is deemed to make navigation comfortable.

To overcome these problems, special review applications have been designed. These solutions principally work for slide-based presentations. Slide overviews allow to access scenes directly in which the presenter discussed the selected slide. Yet, if the lecturer refers to one slide multiple times, the overview is extended by multiple scattered references which makes it confusing.

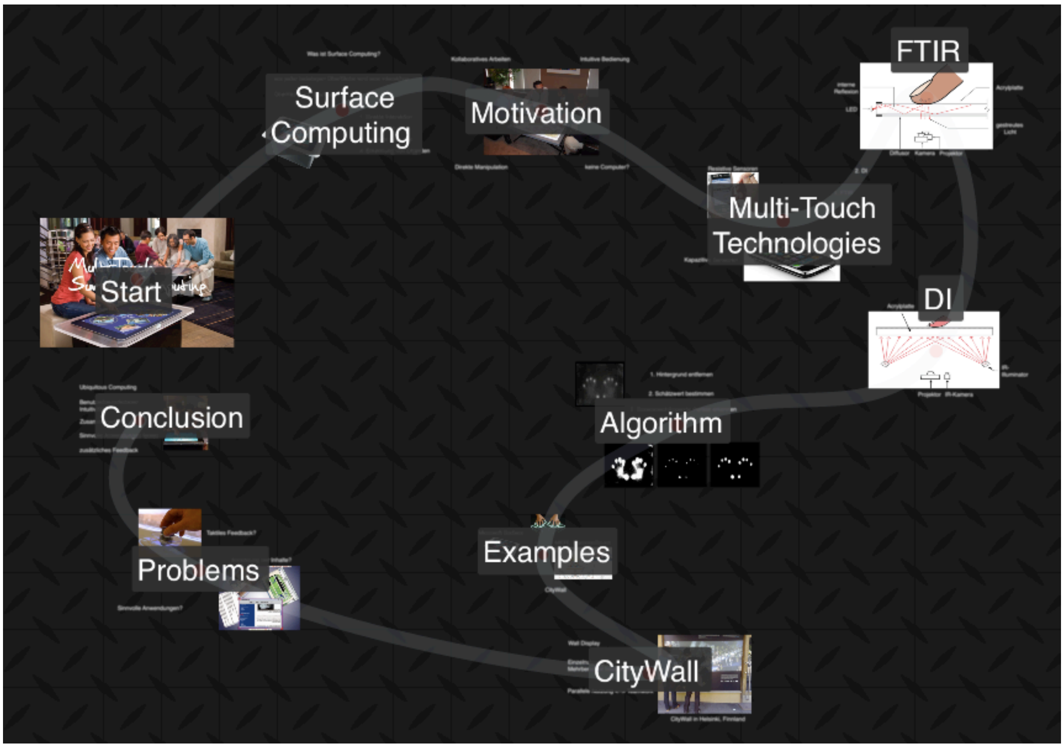


Figure 1.2: A map overview of a Fly presentation on the topic of “Multi-touch and Surface Computing”.

1.2 DragonFly

The idea behind DragonFly is different. Facilitating navigation of the recording already begins with the live presentation. DragonFly enables reviewing of mind map-fashioned presentations (cf. Figure 1.2) authored with Fly[2] that address a human's visual image store. The reviewer uses the original presentation document to look for topics located on the map. A click on a location 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 modes at that location which keeps the map tidy. Thus, DragonFly features a content-related spatial navigation.

DragonFly features a content-related spatial navigation.

[2]http://hci.rwth-aachen.de/fly

Chapter 2

Reviewing Lectures

In the media age, presentations have become widespread means of informing multiple people at conferences, symposia, workshops, lectures, seminars or colloquia.
However, a presentation includes far more than just talking in front of an audience. Before holding a talk, one must collect information, analyse one's aims and optimally adapt the content to the target audience [Feuerbacher, 2009]. In addition, the information must be shaped in a visual form (like slides) that serves as a guideline for the audience. All these steps are belong to the *authoring* process [Lichtschlag, 2008].

Holding a talk requires authoring.

When the presenter has finished performing, discussions initiated by the audience are often joined immediately. It enlarges upon the topic represented and tries to clear up questions.
Even weeks after the live performance, the audience could be interested in parts of the talk that have been forgotten meanwhile or still remain unclear. This recapitulation after the live presentation appears unter the heading of *reviewing* (cf. 2.2—"Reviewing a Lecture").

Reviewing deepens the knowledge acquired through the topic presented.

In this chapter I will first contrast two authoring tools (cf. 2.1—"Slideware vs. Fly"). Then I will focus on reviewing material and in this context concentrate on lecture recordings. Further information about presenting as a task can be found in Feuerbacher [2009] and Lichtschlag [2008].

2.1 Slideware vs. Fly

Common presentation software sticks to the slide metaphor.

Adopted from the old technique of slide-projectors, modern software still refers to the slide metaphor for authoring presentations. Common examples of this so-called *slideware* (cf. Lichtschlag et al. [2009]) are Microsoft PowerPoint[1] (cf. Figure 2.1), Apple Keynote[2] and OpenOffice Impress[3] . The material to be presented is distributed on digital sheets in landscape format containing keywords, images and videos.

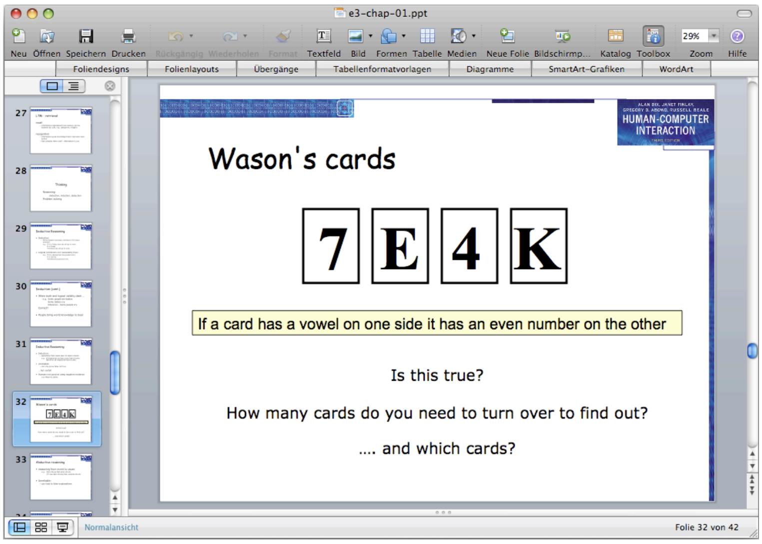


Figure 2.1: Microsoft PowerPoint 2008 in authoring mode. Left: The slide overview. Middle: A PowerPoint slide.

The slide metaphor is out-dated.

PowerPoint is the most popular among these slideware examples. There are about 400 million copies worldwide which results in a market share of 95% [Feuerbacher, 2009]. However, the slide metaphor is out-dated. On the one hand, transparencies are limited in their space each, whereas a monitor can display bigger sheets dynamically. On the other hand, from a set of related slides, only adjacent ones are perceived as being coherent.

[1] http://office.microsoft.com/powerpoint
[2] http://www.apple.com/iwork/keynote
[3] http://openoffice.org/product/impress.html

A new and different way to present is Fly (cf. Figure 2.2), developed by Lichtschlag et al. [2009] at the Media Computing Group of RWTH Aachen University. It creates presentations unlimited in their space and it is more flexible than PowerPoint and the like. Fly's zoomable user interface allows to "fly" over a mind map and reveal details by zooming in. This concept is more contemporary and has many advantages over slideware, such as a more dynamic presentation flow or a clearer demonstration of interrelationships.

Fly is a presentation tool that refers to the concept of a mind map.

Figure 2.2: Fly in authoring mode. Middle: The Fly mind map with its content arranged along the presentation path. Right: A list of stops that determines the presentation sequence.

Since my application designed for this thesis is based on Fly, I will give a short overview of the conceptual differences between PowerPoint (from now on called in the place of slideware) and Fly.

Fly and PowerPoint have different concepts.

- **Slides vs. Stops.** Stops in Fly can be considered as equivalent of slides since they contain text and images. The difference is that a stop is a snapshot taken of the Fly mind map at a certain zoom level. It is added to the path displayed on the map which the lecturer follows during the presentation.
- **Focus and Zoom.** In Fly, the author can choose any zoom level for a stop; the closer the distance to the

map, the larger the font size becomes and details of images become visible. Zooming out shows an overview of the map. PowerPoint has only a static focus on the slides.

- **Presentation Flow.** PowerPoint allows to follow one presentation sequence only. Fly, in contrast, is able to define multiple paths in one document. Furthermore, the lecturer is not forced to follow a route during the presentation as she can target at any location on the map at any arbitrary zoom level.

- **Media.** Slides can be filled with text, images, audio and video files. At its current development status, Fly only supports text boxes and images (also called "nodes") to be put on the map. Yet, the font size is dependent on the zoom level, i.e., a zoom-in enlarges the font of a text snippet.

- **Layout.** Headings and bullet points are distinguished by using different font sizes, locations and colours for the text in PowerPoint. By contrast, Fly uses a two-layered[4] mind map to separate headings from content. Headings appear on top of a stop. By zooming out these topic layers are clearly readable whereas underlying keywords are blurred. Zooming in slurs the headings and text boxes become clearly readable.

2.2 Reviewing a Lecture

Reviewing is a necessary task.

A presentation contains much information in a compressed form. Of course, we cannot store all the information available to our brain since a human's short term memory is limited in capacity [Dix et al., 2004]. Hence, if the listener wants to recall individually facts presented that she has forgotten or not understood, it would be helpful to gain an insight into the topic even some time after the talk. This task is called *reviewing a lecture*.
In this thesis, I focus on university lectures as presentations and henceforth refer to the reviewing audience as students.

[4] detail layer vs. topic layer, cf. Figure 2.2

2.2.1 Review Material

There exist different sources that can be utilised for reviewing. Often, the author provides them as supplementary material to the talk. Common types are:

A lecturer provides different media for reviewing.

- **Printouts.** The slides and/or whiteboard annotations are printed on paper or are available for download. These documents can be expounded by additional annotations from the author.
- **Handouts.** The crucial facts of the talk are written down in form of notes on one to two pages.
- **Transcripts.** A transcript is a written form of the presentation talk which describes the content of a series of lectures with added illustrations in a compact and coherent manner.
- **Books.** A bibliographical reference to books that cover the topic helps the reviewer to deepen her knowledge.
- **Recordings.** Audio or video recordings of the live talk keep all auditive and visual information as presented (cf. 2.3—"Lecture Recordings"). This media comes closest to the live experience in the lecture hall (cf. Figure 2.4).

Naturally, the listener herself can capture information of the talk for later review as well. For example, she can take notes, take photos of projected slides or use a Dictaphone to record the presenter's voice [5].

The audience keeps the information.

Since my thesis deals with the navigation of lecture recordings, I will evaluate why these recordings are useful for reviewing and reveal why ordinary playback software is not useful for reviewing.

[5] Of course, for the latter two options, the listener needs the permission of the author or presenter.

2.2.2 A Demand for Lecture Recordings

Watching lecture recordings is becoming more and more poplar amongst students. Meinel [2009] presented recent download figures for two popular lecture archives at the eLectures 2009 Workshop[6] .
The tele-TASK[7] system developed by the Hasso Plattner Institut (HPI)[8] provides about 2,000 recorded lectures and presentations. In July 2009, more than 700,000 downloads have been registered for the video pool. Till September 2009, a total of 15.7 million recordings have been downloaded.
The HPI is also represented at iTunes U. Approximately 15,000 downloads per week prove a high demand for this kind of eLearning for students of the HPI.

iTunes U and tele-TASK are two popular platforms which provide lecture videos.

Concerning Meinel, recordings in the field engineering and computer science have the highest demand of all lecture videos worldwide.

2.2.3 Benefits of Lecture Recordings

Especially for students, lecture recordings have several benefits either as replacement for a live lecture or as supplementary material for reviewing.

A lecture recording can be adjusted to the student's learning rate because it can be paused or played back faster resp. slower. Students that have advanced knowledge of the topic presented may consider the live lecture as a waste of time [Ketterl et al., 2008], whereas beginners, on the contrary, may wish to slow down playback speed [Rowe et al., 2001, Krüger, 2005]. In this context taped lectures are also useful for non-native speakers as they can calmly review what they have not understood in the live talk.
In general, lecture recordings offer more temporal and local flexibility [Zupancic and Horz, 2002, Krüger, 2005]. This holds true for the field of eLearning in general, since

The student can determine the lecturer's pace individually.

[6]http://delfi2009.electures.info/
[7]http://www.tele-TASK.de
[8]http://www.hpi.uni-potsdam.de/

it focuses on distant teaching. For example, downloading a lecture video and uploading it to an iPod allows more flexibility and freedom for studying.

Lecture videos are portable.

For those who attend the live lecture, taped lectures are also beneficial. Note taking — which is prone to error and requires a student's full attention [Brotherton and Abowd, 2004] — can be reduced since a recording covers all details of a talk. Missed parts can be retrieved from the video.

A recording keeps all details of the live lecture.

Confirmed by several studies and surveys, students use lecture videos along with slides for solving exercises, working on projects and for studying for exams [Brotherton and Abowd, 2004, Zupancic and Horz, 2002] (cf. also 4—"Initial Survey"). Log files showed that access to lecture videos reaches a peak around examination period [Krüger, 2005].

Lecture recordings are used to study for exams.

Interestingly, lecture recordings do not encourage students to skip the live lecture [Brotherton and Abowd, 2004]. In general, students consider recordings as supplementary media instead of a replacement.

A recording is no substitute for a live talk.

Researchers tried to find out whether students who work with the recordings perform better in exams than those who do not watch lecture videos. Yet, it is difficult to "measure" learning success of a student. A recently published medical study by McNulty et al. [2009] revealed that students using the recordings performed significantly worse compared to those using no videos. On the contrary, a study by Zupancic and Horz [2002] revealed that recordings have no influence as to exam performance. However, students feel positive influence by recordings and they support them in their studies to retain knowledge or to get clarification on questions that they have. He et al. [2000] detected that reviewers having slides and a lecture recording at their disposal performed better in solving exercises than those only having slides available.

Students consider lecture videos to be helpful for their studies.

2.2.4 Navigation Problems

Reviewers are interested in directly accessing particular scenes of a lecture video.

Since students do still attend the live lecture, they are familiar with the content, i.e., they roughly know which topics are covered by its recording. Consequently, the students are interested in having direct access to different themes discussed in the video [Hürst, 2002, Padhye and Kurose, 1999, Rowe et al., 2001]. Of course, one can open the video with a software such as Windows Media Player or Apple QuickTime Player. These programmes are equipped with controls for play, pause, fast forwarding or rewinding (cf. Figure 2.3). In addition, there is a timeline slider that allows to jump to arbitrary video positions.

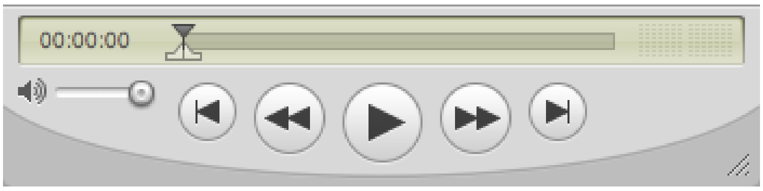


Figure 2.3: QuickTime Player controls. A timeline slider and buttons for playback and rewinding resp. forwarding control the video.

Video players provide only universal tools for navigation.

However, such controls fail in case of an issue-related search. The buttons and the slider are to control universally any video, regardless of whether it is a movie, a podcast or a taped lecture. For example, a direct jump to a position in the video where the lecturer switched over to a new slide cannot be found directly[9].

Direct manipulation tools that use trajectories as navigation control are inadequate for lecture videos.

In addition, lecture videos contain few scene changes compared to other video material. Therefore, direct manipulation controls such as DRAGON (cf. Karrer et al. [2008]) or DimP (cf. Dragicevic et al. [2008]) that allow to drag moving objects in the video to forward it do not facilitate navigation in this context. More navigation facilities for common videos are discussed in Brockly [2009].
Solutions that try to solve navigation problems occurring with captured talks are discussed in 3—"Related Work".

[9]no luck assumed

2.3 Lecture Recordings

Taped lectures are different from videos such as movies or clips. As said before, a lecture recording contains fewer scene changes compared to other types of video as the presenter needs some time to discuss a slide. In addition, speeches by the presenter are unscripted and spontaneous compared to a movie or music video. Besides, domain-specific vocabulary is used [Cao and Nunamaker, 2004].

Lecture recordings differ from other types of video.

2.3.1 Audio and Video

Generally, there are two types of lecture recordings, namely audio- and video-taped presentations. The latter type contains more information and has become more popular due to increased internet bandwidth.

Video recordings capture more information than audio-taped talks.

Audio-taped lectures mainly contain the voice of the presenter. For better quality, the docent wears a microphone close to her mouth. Some recordings even include the audience. For example, if someone has a question, a microphone can be passed to the person asking to integrate her voice to the recorded stream. Hence, any reviewer can listen to questions posed by others that could also be interesting for her.

The audience can be recorded as well.

For video-taped lectures, there exists more material that could be interesting for a recording. First of all, there is the presenter. This includes her facial expression and gestures. For example, the lecturer could try to explain something with the aid of pantomiming. In addition, the recording of presented material, such as slides projected onto a wall or sketches on the blackboard, is also demanded by reviewers (cf. 4—"Initial Survey"). Especially when the presenter tries to get the audience's attention by pointing at elements of the slides or whiteboard, a reviewer can quickly identify during replay what the presenter is currently talking about. Often, the professor and the presented material are filmed in one stream. Multiple camera recordings do also exist but they are usually cut and edited into one video file [Mukhopadhyay and Smith,

A lecture video often includes the presenter's gestures and the filmed presentation material.

Figure 2.4: A video frame of a lecture recording. Projected slides (left), the presenter (right) and annotations on a whiteboard (behind the presenter) are recorded. Since the camera and the students share the same perspective, the recording comes close the the live experience of being inside the lecture theatre.

1999]. Besides camera recordings, demonstrations of software are kept with screen capturing software. Apple's QuickTime X, recently included in their operating system "Snow Leopard"[10] , saves interaction on the screen in a video file.

2.3.2 Captured Interaction

Special navigation software is dependent on captured interaction.

Special review applications for taped lectures (cf. 3—"Related Work") often need more information to be recorded during the presentation. The idea is to provide the digital presentation material such as slides next to the recording view. Navigation within the video shall be facilitated by synchronising the material with the audio or video file. For this to function, the lecturer's interaction with the presentation software has to be recorded next to the audio and video streams. So-called *time stamps* are extracted whenever the professor launches a new slide, for example.

[10] http://www.apple.com/macosx

Chapter 3

Related Work

As explained in 2—“Reviewing Lectures”, lecture videos are different from other video types like movies. Whilst the latter type is watched from beginning till end, reviewers generally watch specific parts of a lecture recording [Soong et al., 2006]. This chapter introduces navigation facilities and systems that include them.

3.1 Navigation Facilities for Lecture Recordings

Mertens et al. [2004] have summarised navigation facilities for lecture videos. All features are adapted to recordings of slide-based lectures and shall help students to immediately find and access the correct scene they are looking for.

There exist special navigation facilities for lecture recordings.

- **Time-based Navigation.** The review system supplies a timeline slider that allows to jump directly to diverse video positions. Ideally, it features *random visible scrolling*[1], meaning that any interaction with the slider updates the video frame immediately [Hürst and Jarvers, 2005] and unveils animated slide elements[2]. A slider can also speed up playback.

[1] also known as real-time random access
[2] Imagine a scene, in which a docent writes annotations on a slide.

- **Silde-based Navigation.**
  - *Basic Slide-based Navigation.* The interface provides a list of slide titles or features a thumbnail overview showing miniature transparencies. Each item is linked to a time position in the video: A click on a title or thumbnail causes the video to be forwarded to the time the presenter discussed the slide. Unlike a slider, this navigation control is tailored to the content of the lecture.
  - *Advanced Slide-based Navigation.* As basic slide based navigation only allows to call the beginning of each slide, this feature might be too coarse if someone likes to jump to chunks or other slide items like images, i.e., to the time the lecturer explained these elements. Especially when the time taken to talk about a slide is too long[3] students demand for finer navigation.
- **Full Text Search.** By entering keywords the according slide is displayed and ideally the video jumps to the appropriate position in time when the presenter explained the corresponding term.
- **Backtracking.** This feature enables to undo any navigation step. For example, if a student jumps forward from video position t_0 to time t_1 then backtracking should allow to restore time position t_0. To help the student reorient herself to that position, the software should rewind to some seconds earlier than t_0, for example $t_0 - 3$ seconds.
- **Bookmarks.** A bookmark function enables to store video positions which the user might want to access at a later time. Moreover, these bookmarks can be labelled.
- **Footprints.** All time intervals of the lecture video that have been reviewed are tracked and displayed. This helps the reviewer to distinguish parts that have been viewed from those that have not and maybe should be watched as well.

[3] in this context too long means longer than three minutes (cf. Padhye and Kurose [1999] and 4—"Initial Survey")

3.2 Lecture Video Review Systems

Since the beginning of recorded lectures, researchers have developed different applications to overcome navigation problems of this media. However, since the mid 2000s research seems to have slowed down in this field although lecture videos are popular among students nowadays (cf. 2.2.2—"A Demand for Lecture Recordings").

Special reviewing software implements navigation facilities.

3.2.1 Classroom 2000 / eClass

The eClass[4] project was developed by Abowd et al. [1998]. The idea of eClass is to prepare digital slides with some keywords, static images or empty sheets and fill them with content by hand-written annotations on an electronic whiteboard (cf. Figure 3.1).

The presenter works with an electronic whiteboard.

Every pen stroke by the instructor is recorded, i.e., time-stamped. To access specific parts of the recording, the reviewer has to click on the digitalised hand-written words. The embedded audio- and video player forwards the recording to that time when the presenter wrote these notes. Hence, eClass offers fine-grained advanced slide-based navigation. However, this navigation is considered to be not ideal since only 27% of the participants of a study used ink-level access [Brotherton and Abowd, 2004]; the majority preferred slide-level access which is also supported by eClass.

eClass offers word-level access.

Another downside of these time stamps is that they result in asynchronous playback of the video since lecturers tend to explain before writing down.

Time-stamped digital ink is asynchronous.

A clear advantage of eClass is that the synchronisation between hand-written slides and the video needs no manual post-production. Nevertheless, the presenter needs to adapt too much to the system since it only unleashes its full power if hand-written slides are created on the fly.

eClass does not need any post-production.

[4] formerly known as Classroom 2000

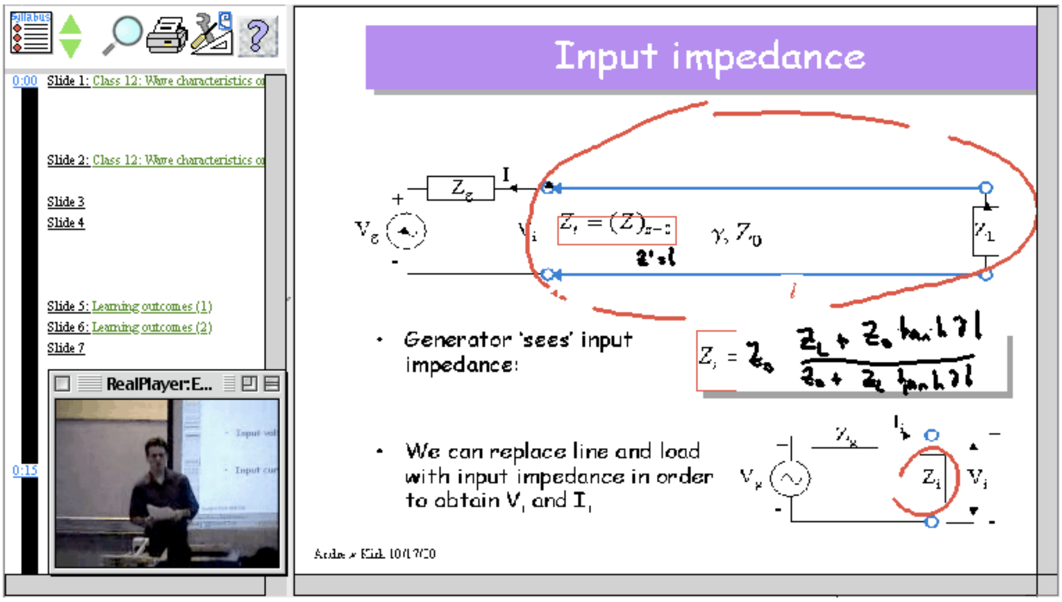


Figure 3.1: The eClass interface. Left: A list with all slide titles for basic slide-based navigation. Right: A currently discussed slide which is synchronised with the video displayed in the bottom left hand corner.

3.2.2 ePresence

ePresence minimises post processing.

The ePresence system has been developed at the Knowledge Media Design Institute, Toronto [Baecker, 2003, Toms et al., 2005, Dufour et al., 2005, Rankin et al., 2004]. It creates (interactive) webcasts from recorded lectures including their presentation material at a minimum of post-production.

ePresence supports a chat for broadcasted live presentations.

The ePresence archives support videos, slides and live desktop demos for reviewing. In contrast to other web-based lecture review solutions, ePresence focuses on interactivity since it integrates a moderated chat for students to discuss the lecture.

For archived lectures the interface setup is shown in Figure 3.2. The video window and its controls are arranged in the upper left hand corner. In the middle, the current slide is depicted. The associated buttons allow to skim the slides back and forth (basic silde-based navigation). Furthermore, the slides can be accessed via the index next

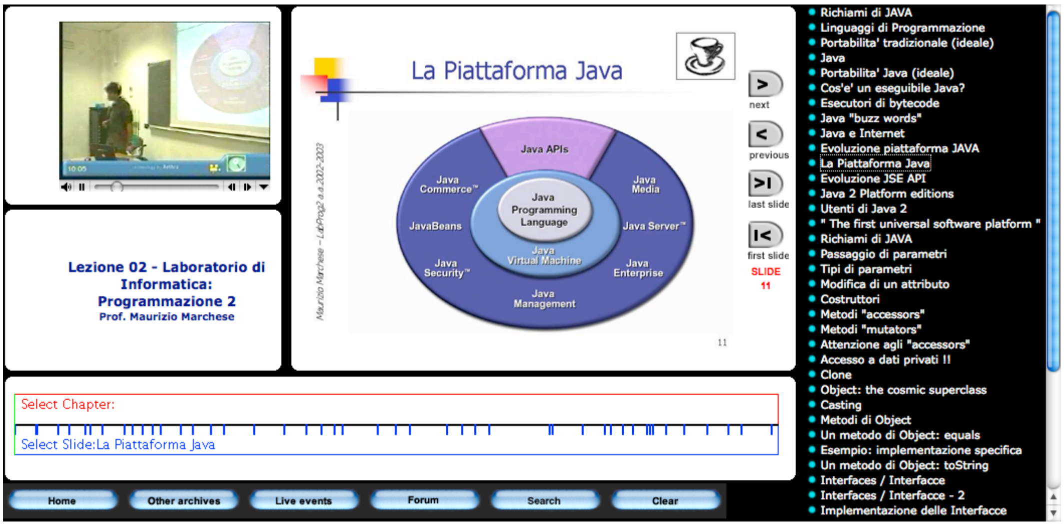


Figure 3.2: The ePresence interface for an archived lecture. The video is synchronised with the slide, the advanced timeline at the bottom and the index on the right hand side.

to the slide. Below the currently displayed slide, ePresence offers an advanced timeline slider. Its markers indicate when slide transitions appear in the video. Hovering over a marker fades in the title of the slide which is synchronised with the video by click.
Broadcasted live presentations do not feature an advanced timeline or index. Instead, a chat enables to post messages and displays all viewers' nicknames.

Basic slide-based navigation is supported by ePresence.

If PowerPoint is used for presenting, time stamps and slide text are extracted automatically. In addition, a keyword search puts highlights on the timeline if the query matches the content of the according slide.

Time stamps are extracted when PowerPoint is used for presenting.

Trento University in Italy is one example[5] that uses ePresence [Rankin et al., 2004].

3.2.3 Authoring on the Fly (AOF)

The Authoring on the Fly (AOF) system by Hürst et al. [2000] features a special query search. Besides text, AOF

[5] http://ortles.dit.unitn.it

AOF ranks search results by layout analysis.

extracts the layout of a matching term found on a slide, i.e., it analyses whether the search result appeared in a slide's title, whether it is coloured or whether its text is bold. The more of these items apply to the result, the higher its ranking is. In doing so, students shall find more important query results on top of a list and pick them first.

AOF supports basic slide-based navigation.

The AOF WhiteboardPlayer (cf. Figure 3.3) features basic slide-based navigation via a slide overview. However, AOF is not designed for video playback. The idea is to record the lecturer's voice simultaneously with annotations written on an electronic whiteboard. When the audio stream is played back, the annotations are fluently superimposed on the currently displayed slide[6].

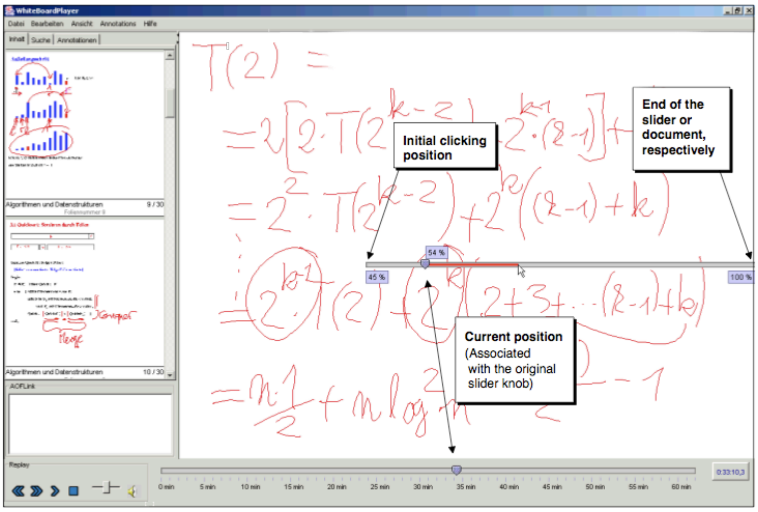


Figure 3.3: The AOF interface. Left: A slide overview and playback controls. Right: The currently displayed handwritten slide with the superimposed Elastic Panning slider.

Elastic Panning solves the slider resolution problem for time-based navigation.

AOF is also equipped with time-based navigation that solves the so-called slider resolution problem. For example, a video lasting 60 minutes and a slider's width of 500 pixels means that using the slider one can only access every 7.2 seconds of the video. Hence, dragging the slider results in jerky updates of the digital ink. As a solution, Hürst and Götz [2004] integrated *Elastic Panning* into AOF.

[6]This looks like an invisible person is writing on a whiteboard.

By clicking elsewhere in the AOF document window, a new slider is displayed whose knob is associated with the original slider (cf. Figure 3.3, right). If the reviewer moves the mouse cursor horizontally, the video starts skimming automatically. The distance between the initial and the current cursor position determines the scrolling speed. The idea reminds of a rubber band: The smaller the distance, the slower the scrolling speed. Consequently, fine[7] scrolling resolutions are possible such that jerky movements are eliminated by smooth frame transitions. Yet, this control is not content-related.

Elastic Panning uses a rubber band metaphor.

3.2.4 virtPresenter

One method of automatically indexing a lecture recording is to analyse which parts of a lecture recording have been intensively watched by reviewers. Collecting such data and sharing it with other users is the idea of *social navigation* [Ketterl et al., 2008, Mertens et al., 2004]. VirtPresenter visualises intensively watched parts on a timeline.

virtPresenter features social navigation.

A thumbnail overview featuring basic slide-based navigation shows all slides including their title (cf. Figure 3.4). By hovering over a thumbnail, markers in the footprint bar indicate the time the presenter referred to for the according slide. The time stamp information is extracted from the PowerPoint presentation via an external plugin.

Basic slide-based navigation is supported by virtPresenter.

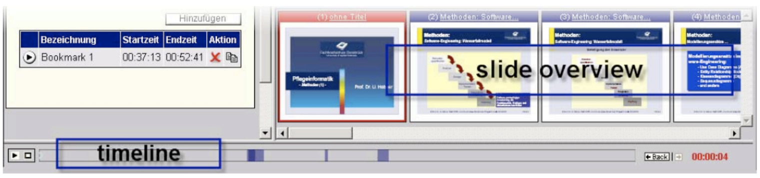


Figure 3.4: The virtPresenter navigation controls. Left: A bookmark list. Right: A slide thumbnail overview with according slide titles. Bottom: A timeline with footprint information (cf. also Figure 3.5).

[7] up to one video frame per slider knob movement

When a reviewer watches the lecture video, virtPresenter automatically traces which parts exactly have been accessed. For each trace detected, the footprint bar is coloured at the according position by a darker shade. The more users watch the same part the darker the shade becomes (cf. Figure 3.5). Basically, virtPresenter distinguishes one's own interaction from other reviewers' footprints.

The navigation behaviour of all reviewers is collected and shared with other users.

When a student clicks on a position in the footprint bar, the associated slide in the thumbnail overview is highlighted. Releasing the mouse button starts playback at that position in the lecture video.

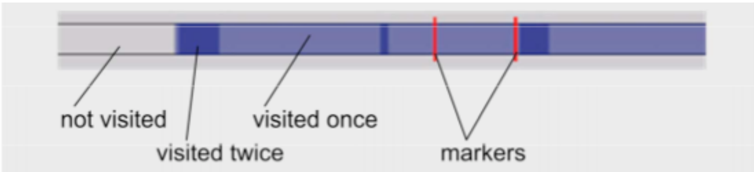


Figure 3.5: The footprint bar. Shades indicate the intensity of access of video segments. Markers visualise the time interval of a currently discussed slide

Furthermore, virtPresenter features adding bookmarks for different playback positions. The timeline displays where which bookmark begins and ends.

Social navigation needs a multitude of users to provide valuable results.

Nevertheless, the concept of social navigation is inappropriate for people who want to retrieve important parts of the video directly after the recording has been published. It takes time and experienced reviewers until virtPresenter has traced enough users to present valuable results. Hence, the lecturer is forced to use PowerPoint for presenting in order to capture time stamps needed for navigation if social navigation data is missing.

3.2.5 Multimedia Asynchronous Networked Individualized Courseware (MANIC)

MANIC is a client/server architecture for synchronising a lecture recording with HTML slides [Padhye and Kurose, 1999, Schapira et al., 2001]. It features a search method that forwards the video to a discussed slide if the query matches the slide's content. Furthermore, students can attach notes to a currently displayed slide.

Students can attach notes to slides.

In addition, MANIC is equipped with basic and advanced slide-based navigation since it allows to index and thus access structural elements of a slide. Such a unit is called a "highlight". The instructor can manually time-stamp single words, bullet points or groups of bullet points. During playback, such elements are highlighted.

MANIC features basic and advanced slide-based navigation.

Besides, MANIC is not equipped with a timeline (slider) since this is not intended by the developers. Skimming from highlight to highlight or from slide to slide is considered to be more useful as it is a content-related navigation.

Using a timeline slider is not intended.

Moreover, MANIC is one of the few systems that support backtracking. Since for each highlight displayed a new HTML page is loaded, the reviewer can use the ordinary back and forth buttons of a browser to undo or redo several navigation steps.

MANIC supports navigation backtracking.

3.3 Overview

This table lists the essential features of the applications presented and anticipates the design of DragonFly.

System	Slides	Slider	Navigation	Special feature
eClass	✓	✓	++, k	word-level access
ePresence	✓	✓	+, k	interactive chat
AOF	✓	✓	+ , k	high resolution slider
virtPresenter	✓	✓	+	social navigation
MANIC	✓	—	++, k	highlights
DragonFly	—	restricted	++*	interaction via mind map, multiple-times-to-one-location-mapping

Table 3.1: An overview of lecture recording review systems.

Legend:

+/++	Basic/Basic & advanced slide-based navigation
++*	Basic & advanced stop-based navigation
k	Keyword search

Chapter 4

Initial Survey

Before planning the design of DragonFly (cf. 5—"Design"), I started an initial survey to find out

(a) whether lecture recordings are used for reviewing and

(b) which problems people have when working with lecture recordings.

The results of the survey helped me to formulate essential design rules for DragonFly (cf. 4.6—"Design Rules for DragonFly").

Participants of the survey were either interviewed personally or filled out an online form. Most of the questionnaires were answered in German; a few participants have chosen the English version. The latter one and the findings of the survey are printed in Appendix A—"Initial Survey Questionnaire" resp. Appendix B—"Initial Survey Results".

The survey was conducted in German and in English.

Due to the fact that the people questioned did not know how a Fly presentation differs from PowerPoint talks, scenarios put in the survey were based on the slide metaphor.

Scenarios were adapted to the slide metaphor.

The online service SurveyMonkey[1] was used for composing the questionnaires. In addition, it collected the answers of the online candidates.

The questionnaires were created with SurveyMonkey.

[1] http://www.surveymonkey.com

4.1 Survey Participants

Most participants were students in the 6^{th} or 8^{th} semester.

A total of 87 students and former students, 77% male, took part in the survey. They were aged 20 to 40; most of the participants were 24 or 25 years old, which is an ideal condition for the examination of lecture review experience. On average, they were in the 6^{th} or 8^{th} semester.
Concerning the students' chosen subjects, the majority of 37% are enrolled in a technical subject, 35% of the students are doing humanistic or social studies and 20% are studying in the field of arts or medicine.

4.2 Reviewing Lectures

Candidates were asked to rank review media.

The survey participants were asked to rank materials like slides, scripts, books etc. by how often they use them for reviewing. It turned out that slides and scripts are used most (cf. Table 4.1). Interview partners confirmed that slides are closest to the lecture, since lecturers often stick to PowerPoint presentations. In addition, transcripts represent a written form of what was taught by the professor.

Lecture recordings are rare.

Whilst recordings provide a lecture experience that comes closest to being inside the real lecture theatre, 82% resp. 65% never work with audio- resp. video-taped presentations. The reason for this outcome is that there are often no recordings provided[2] by the professor. Especially students of non-technical subjects hinted at this. Yet, concerning the participants, 63% definitly want to work with such recordings. Hence, lecture videos are in demand.

Reviewers take notes manually on paper or printed slides.

The questionnaire candidates were also asked which media they use for note taking (cf. question 2.2). 91% prefer taking notes manually, i.e., by pen on paper or printed slides. In contrast, only 2% use special hardware, such as a tablet PC or a LiveScribe pen[3] or software to put annotations on digital slides. Digital ink is rarely used and typing is considered uncomfortable.

[2] or the existence is unknown to the student
[3] http://www.livescribe.com

Media used	often	sometimes	rarely	never
Slides	**50.60%**	31.76%	11.76%	5.88%
Script	**48.24%**	37.65%	11.76%	2.35%
Book	26.74%	39.54%	27.91%	5.81%
Audio recording	1.20%	6.02%	10.84%	**81.94%**
Video recording	3.57%	11.90%	19.05%	**65.48%**

Table 4.1: A ranking of media types for reviewing.

4.3 Working with Lecture Recordings

Participants who have never worked with such recordings so far (so-called unfamiliar users, approx. 57%) got different questions (cf. questions 4.1 - 4.2) than those who have experienced taped presentations (so-called more or less familiar users, approx. 43%) (cf. questions 3.1 - 3.4).

The survey was split into two groups.

Concerning all participants, only 11% reject to work with lecture recordings. Remarkably, none of these have ever listened to or watched a taped lecture. Hence, they may be prejudiced that recordings have a negative influence on their studies. For example, one person was afraid of being lead into temptation to stay away from the lecture hall solely due to the *distribution* of recordings.
Strictly speaking, no-one of the familiar users afterwards said that she was definitely against it.
Both parties were questioned on the desired content of a lecture recording. Approximately 93% think that including the docent's voice is a must. Nearly 79% insist on filmed presentation material (e.g., slides) as well, even if it is available separately. Moveover, 60% are also interested in captured questions of the audience. Hence, the reviewer must be given the opportunity to access isolated scenes that refer to discussions initiated by the audience.

Only 11% reject recordings, but they seem to be prejudiced.

Reviewers want the audience's comments to be captured.

4.3.1 Unfamiliar Users

From those who have not utilised lecture recordings before, almost 76% stated that they had no lecture recordings at their disposal. Only 13% commented that they do not consider captured lectures as useful means of recapitulating the subject matter. In addition, 52% of those who had no recordings at their disposal definitely wanted to use lecture videos for reviewing, whereas 22% clearly refused to do so. In conclusion, the majority of unfamiliar users would like to work with this kind of review media.

Unfamiliar users would like to work with lecture recordings.

4.3.2 Familiar Users

People who already had previous experience with lecture recording material were asked for what purposes they have recourse to this media. Approximately 88% of them make use of the preparation of exams, 50% use them for finding answers to specific questions and almost 71% watch video-taped sessions when they could not attend the live lecture. Among the familiar users, 68% felt a positive impact on their studies due to the recordings, i.e., they were under the impression that they got better results and/or have confirmed knowledge attained. Of course, it is difficult to measure the influence on exam performance through learning materials, but these figures show that students see such material as support for their study. Hence, the results clearly indicate that there exist useful scenarios for the employment of lecture recordings. Interestingly, only 15% approved to drop live lectures and follow the presentation from home only, which is consistent with the results of a another study, where 82% said that they wanted to attend the live lecture in person [Brotherton and Abowd, 2004].

Students watching lecture recordings feel a positive impact on their studies.

Students do not skip live lectures.

Familiar candidates were also asked if they had experienced problems controlling the recording. Exactly 50% said that it took a long time to find a specific scene and 35% had no or only limited access to specific parts they were looking for (multiple answers were possible). Altogether, 67% of people more or less familiar with lecture recordings confirmed having problems with navigation of this media. In this context, the figures mentioned show the students' interests: Generally, they pick specific parts of the video instead of watching it from the beginning.

Most reviewers experienced problems concerning lecture video navigation.

Among the participants having problems with navigation, the majority of 55% experienced difficulties with a standard player whereas 41% only had problems with the navigation of streamed material. The last figure is smaller as some of the web-based lecture media libraries feature basic slide-based navigation (cf. 3—"Related Work").

Standard video players are not useful for lecture recordings.

In conclusion, reviewers access specific parts of a lecture which is considered to be uncomfortable if not impossible by most survey candidates using a standard player.

4.4 Navigation Facilities

Another aim of the initial survey was to find out *how* people (would) like to access specific parts of a lecture video by using facilities such as watching from beginning without jumps, using slide-based navigation or a making use of a slider (cf. question 5.1). 73% prefer slide-based navigation which is far more popular than using a timeline slider (44%). This is consistent with other findings: Only 15% of those who have experienced navigation difficulties want to use a slider. Even more interesting is that 65% of those who have never dealt with lecture recordings before prefer using a timeline slider (cf. Figure **??**) but 61% of those who have experience with such media definitely refuse using this control.

Only 43% use a timeline slider.

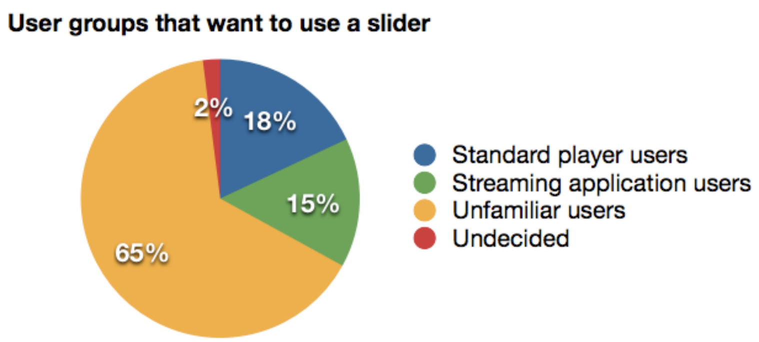


Figure 4.1: User groups that (also) would like to use a slider even if the application features slide-based navigation.

Students clearly indicated (e.g., confirmed by personal interviews) that there is a demand for improved navigation that is not (mainly) based on a slider.

Fine-grained and coarse-grained navigation are both demanded.

In this context the potential users were asked by a given example which level of granularity is acceptable for video position access (cf. question 5.2). The figures in Figure 4.2 show that a lecture video scene that lasts less than 3 minutes does not necessarily need finer navigation methods. But if such a scene lasts longer, more and more people expect in-scene navigation to be possible.

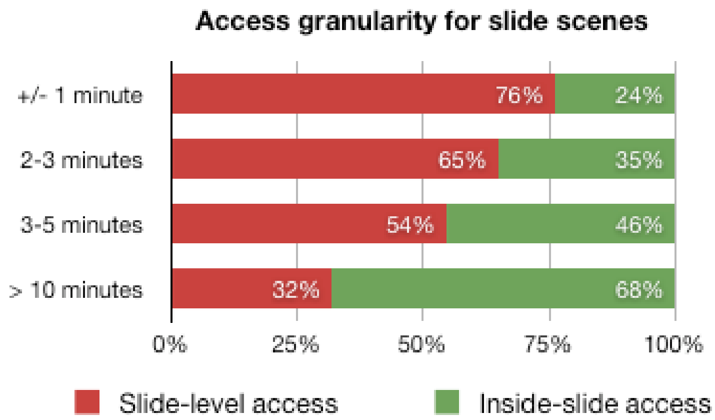


Figure 4.2: If a scene lasts longer than three minutes, fine-grained access becomes more and more relevant.

Reviewers add bookmarks.

Furthermore, almost 71% of the survey participants want to load and store bookmarks in a lecture video. Remarkably, 46% of all participants still rely on their memory for later retrieval of video positions; but some of them add a bookmark as well.

4.5 Special Reviewing Application

Reviewers demand an application with navigation facilities for watching lecture recordings.

Finally, after having introduced some potential navigation functions of a lecture reviewing software by this survey, I asked if the survey users thought whether students benefit from a specially designed application or whether they thought that a standard player is sufficient for navigating the talk's recording. More than 60% said that a dedicated software is useful for such scenarios. In contrast, only 21% stated that ordinary players offer satisfactory results as to video navigation (others are undecided or against lecture recordings). These figures together with the results of the navigation problems indicate that an application tailored to the needs of lecture video navigation is useful and in demand.

4.6 Design Rules for DragonFly

Extracted from the results of this survey, DragonFly should satisfy the following design rules:

D1	**Close Lecture Experience**. DragonFly must provide an experience close to the live presentation by using a video and the presentation material, both.
D2	**Flexibility.** DragonFly must enable reviewers to have direct access to scenes where the presentation flow was interrupted, e.g., by students who asked questions.
D3	**Direct Access.** Navigation to single (independent) lecture units must be possible. In the case of DragonFly, each beginning of a stop must be directly accessible.
D4	**Direct In-Scene Access.** For single (independent) lecture units, a structured direct in-scene access must be offered.
D5	**Overview.** DragonFly must provide an overview that allows to access the (independent) lecture units directly.
D6	**Reduction of Sliders.** Navigation by a timeline slider should be secondary.
D7	**Slider Resolution.** A timeline slider should have such a resolution that distinct elements of the lecture video can be accessed.
D8	**Bookmarks.** A bookmark function must be implemented that allows retrieving personally marked video positions.

Table 4.2: DragonFly design rules

Chapter 5

Design

Whilst Fly is designed to present a talk with the aid of a zoomable mind map, DragonFly is meant for reviewing such a presentation.
During the presentation, Fly stores time stamps to the presentation document. By opening that file in DragonFly, the document is shown with the corresponding lecture video next to it. The basic idea is to navigate the video by interacting with the map, i.e., a content-related spatial navigation.

DragonFly features content-related spatial navigation for recorded Fly presentations.

Next to the design rules (D1 - D8, cf. 4.6—"Design Rules for DragonFly"), DragonFly will meet two basic principles:

P1 **Minimisation of Post-production.** After the live talk, the material (document, video) should only need very little post processing in order to work with DragonFly.

P2 **No Slide Metaphor.** DragonFly shall enable reviewing of presentations that do not stick to the slide metaphor.

In this chapter I decribe tools used for the implementation as well as design changes to Fly and features of DragonFly.

5.1 Technical Background

DragonFly is designed for Mac OS X 10.5 Leopard.

Fly and Dragonfly have been developed for the Apple Mac OS X 10.5 Leopard[1] operating system. Both applications are based on the following frameworks: Cocoa, CoreData, CoreAnimation and QuartzCore. DragonFly, in addition, depends on the QTKit framework.
The implementation was done with the Apple Xcode[2] editor (version 3.1.2) and started in July 2009. Fly and DragonFly are stored on the DVD attached to this thesis.

5.2 Changes to Fly

Fly captures time stamps during the presentation.

In order to enable DragonFly to synchronise the Fly document with the attached recording of the talk, a few modifications to Fly were necessary. The modified version, based on the Beta 2 build, is called “Fly for DragonFly”[3].
Generally, the data model of a Fly document has been extended to save time stamps that are captured during a presentation.

The presenter can leave the presentation path.

When the lecturer starts the presentation, a stopwatch starts counting in the background. Whenever the professor switches from one stop to another, time stamps are stored to the data model of the presentation document. Even if the lecturer needs to leave the path to present additional material located on the Fly map, she can indicate by keystroke to leave the track, move to the desired location by mouse or trackpad and fix the document’s perspective to the new position [D2].

A click on a node is time-stamped.

In addition, if the presenter clicks on a node, this interaction is also time-stamped. This has two advantages: On the one hand, if the lecturer selects a node, it is highlighted during the presentation and catches the audience’s attention (cf. Figure 5.1). This highlight is taken up in the review again (cf. 5.3.3—“Highlights”). On the other hand,

[1] http://www.apple.com/support/leopard/
[2] http://www.apple.com/macosx/developers/#xcode
[3] From now on I will just call it “Fly”.

a time-stamped node allows to access directly the video position when the professor talked about that item. Then, in DragonFly, the reviewer clicks on that node in the open document and the video is forwarded accordingly. Hence, a stop can be subdivided and finer parts are accessible for the reviewer [D4].

Of course, it is doubtful if any presenter is willing to use a mouse during the talk to click on the nodes. For the DragonFly user study (cf. 6—"Controlled Experiment with Potential Users"), I used a touch-sensitive SmartBoard to avoid clicking during the talk (cf. Figure 5.1). Nowadays, lecturers use tablet computers with digital ink to emphasise bullet points on slides. Therefore, using a SmartBoard for touching the nodes is no additional burden for the lecturer.

A touch screen makes time-stamping more comfortable.

Figure 5.1: Highlights. A clicked or touched node is highlighted by a blue frame to catch the audience's attention.

Fly minimises post-production dramatically [P1]. Staff only needs to determine an offset value which is the time difference between the start of the presentation and the camera. No trimming of the recording or manual time coding is necessary.

Fly needs very little post-production.

Finally, in conjunction with the DragonFly user study (cf. 6—"Controlled Experiment with Potential Users"), some further modifications were done to Fly to make the presentation task more comfortable. On the one hand, Apple Remote[4] support has been enabled so that the presenter is

Fly supports the Apple Remote as presenting device.

[4] http://store.apple.com/us/product/MA128G/B

not dependent on a keyboard. On the other hand, typing the number of a stop directly turns over to that stop and allows the presenter to change the path sequence.

5.3 Design of DragonFly

The following paragraphs focus on design aspects of DragonFly. The navigation facilities seize upon the findings of the initial survey (D1 - D8, cf. 4.6—"Design Rules for DragonFly").

5.3.1 Graphical User Interface (GUI)

The idea of DragonFly is to control a lecture recording by navigating with the original Fly document (as seen in the live presentation) instead of working with slides [P2].

The presentation document and the lecture video are arranged next to each other.

For each document opened in DragonFly, a new window is shown. Each window consists of a toolbar (cf. Figure 5.2, top), two adjacent views and a slider with video playback buttons (cf. Figure 5.2). The left view displays the document at a ratio of 4:3 by standard. The corresponding lecture video, which is automatically loaded form hard disk with the document, is shown next to the document at the same ratio [D1]. Yet, the reviewer is free to resize the views, i.e., she can enlarge the document's display size by reducing the video's dimensions and vice versa.

In accordance with the *Gestalt Laws* (cf. Smith-Gratto and Fisher [1999]), the slider, the restart and and the play/pause button are located below the video.

Using a slider is secondary.

The slider supports random visible scrolling but it is restricted to the time of the currently played back stop in the video. This is done to provide a higher slider resolution compared to a universal slider that maps the entire video time [D7].
Via the toolbar, the reviewer can add bookmarks and notes to the document. These features including location backtracking will be explained later.

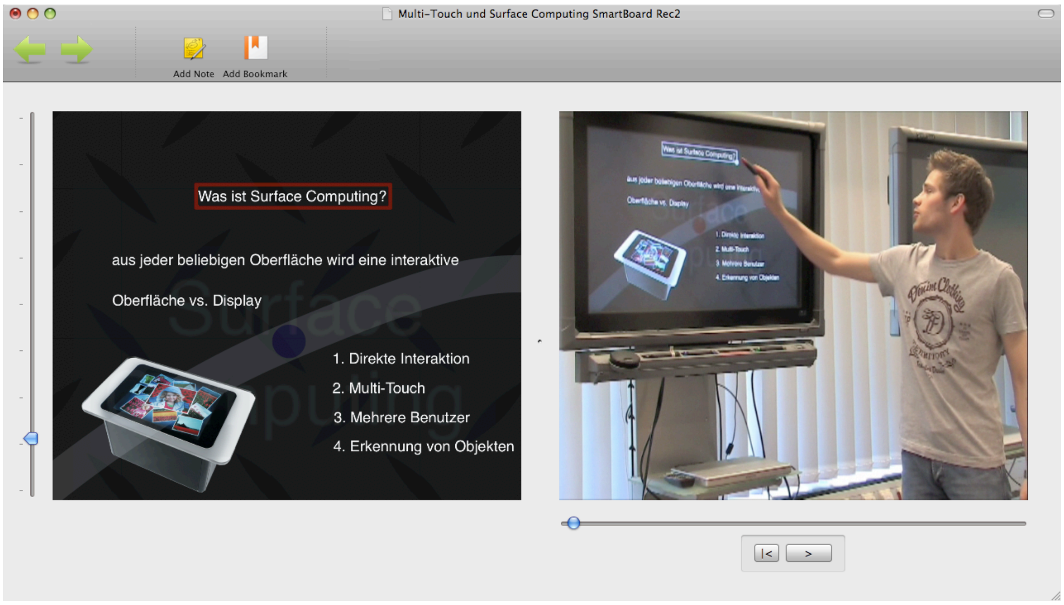


Figure 5.2: The DragonFly GUI. The presentation document on the left and the synchronised video on the right show the same content. A vertical slider on the very left adjusts the map's zoom level. The timeline slider at the bottom is limited to the currently played back stop in the video.

5.3.2 Spatial and Content-related Navigation

The video is navigated by interaction with the document.

In order to convey an experience close to the live lecture during a review session, the video and the presentation material are arranged next to each other. It is the Fly map and its content that the reader presented to the audience; the material is therefore familiar to the reviewer[5]. Working with the document offers a lecture-individual navigation compared to universal standard video playback controls.

The reviewer can explore the entire mind map while the video is playing back.

A student can move freely inside the mind map and zoom in and out as known from the Fly application. This has no effect on the video's playback and allows the reviewer to explore the document and inform herself about topics [D5]. Synchronisation from document to recording is only triggered if the user clicks on time-stamped nodes, stops or bookmarks.

[5] at least if she attended the live lecture which holds true in most cases (cf. Rowe et al. [2001], Brotherton and Abowd [2004])

A click on a node forwards the video to the time at which the presenter discussed the item. The same holds true for stops [D6]. DragonFly calculates the geometric boundaries of a stop by scanning all nodes near the snapshot's centre. A coloured topic layer, called *stop layer*, covers the stop's dimensions. If the reviewer clicks on the layer, the map is zoomed in and the video is forwarded to the time the stop shows up [D3].

DragonFly features basic and advanced stop-based navigation.

Figure 5.3: Stop layers. Each of the three blue shapes covers the dimension of a stop. A click on a layer zooms the stop in and forwards the video (basic stop-based navigation).

Multiple time stamps can be mapped to one item.

Of course, a presenter sometimes needs to refer to a topic multiple times, meaning several time stamps map one node or stop. In a review session it is thus unclear to which time the user wants the video to be forwarded.
In DragonFly, clicking on a multi-stamped element fades in a circle with coloured segments on top of the item, a so-called *multiple choice circle* (cf. Figure 5.4, left). Each segment is numbered and linked to a time stamp. The segments are chronologically ordered and start at the twelve 'o clock position. This is considered to be a natural starting point of a circle, like a clock-face. The angle of each segment relatively represents the time span of a stamp. This spartan time information is deemed to help the user to identify more informative parts[6]. Giving precise time data would overload the interface.

Multiple choice circles let the user decide to choose a time stamp.

As long as the multiple choice circle is visible, playback is paused so that the reviewer can choose a segment.

[6]more discussion time equals more information, assumed

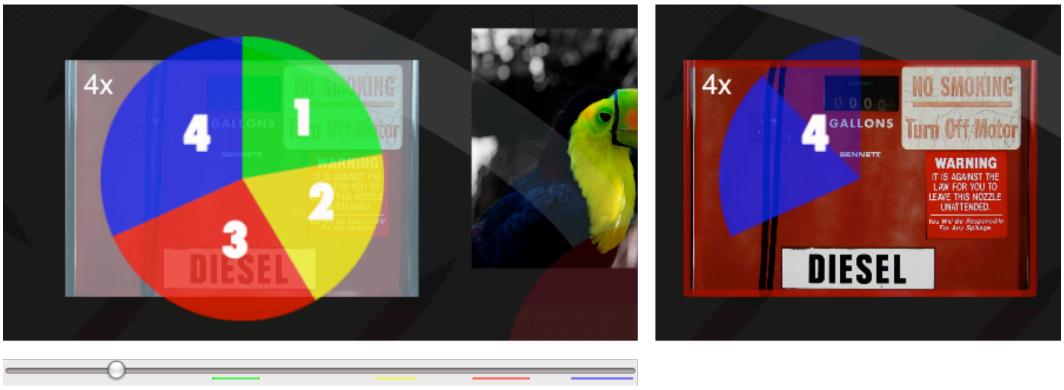


Figure 5.4: A multiple choice circle. Left (top): A circle with four segments meaning that the presenter has talked about the underlying picture four times. Left (bottom): The timeline for silder-based navigation with coloured markers referring to the multiple choice circle. Right: The fourth segment has been selected and is being filled while the video is playing back.

A selected segment provides visual feedback.

Selecting a segment makes its colour more transparent and all other parts of the circle are hidden. The video is synchronised and the segment is filled by its colour clockwise (cf. Figure 5.4, right). When the shape is complete, it vanishes immediately.

The slider displays multiple choice segments.

In addition to the selection circles, the timeline slider is extended by coloured marks. For each segment there is a horizontal line in the same colour. Its width is relative to the segment's time stamp (cf. Figure 5.4, bottom left). This helps to find out whether the segment rather refers to the beginning or to the end of a stop's discussion time.

A heat map reveals intensively discussed topics.

So as to figure out quickly which stops are probably most important[7], DragonFly features a *heat map*.
All stops are ranked by discussion time. Intensively discussed stops get a reddish stop layer on top whereas less regarded stops are coloured bluish. There is a fluent transition from "hot" to "cold" according to the ranking values. A snapshot's centre, depicted by a bubble, is also coloured. In addition, the bubble's diameter increases the longer the discussion time is (cf. Figure 5.5).
Regarding the heat map, a reviewer can find out quickly which stops are more important and which ones are not.

[7]more discussion time equals more information, assumed

Figure 5.5: The heat map. The right stop has been discussed more intensively, since its centre is bigger and more reddish compared to the small blue bubble on the left.

The video automatically synchronises with the document's perspective.

During playback, the document's camera, i.e., the currently displayed part of the Fly map, automatically synchronises with the video. In doing so, the reviewer working with the document always stays in track with the current video position; the video's content and the document's focus are equal (cf. Figure 5.2).

5.3.3 Highlights

A highlight informs the reviewer which node is currently discussed.

Furthermore, time-stamped nodes are highlighted by a red border to attract the reviewer's attention. Whenever the presenter touched resp. clicked on a node during the talk, this highlight appears in the video (as seen in the live presentation) but also in the document (as a red border) (cf. Figure 5.2). In doing so, the user immediately knows which topic the lecturer is currently talking about. If the video does not show the presenter or only an audio recording is available, this is essentially helpful for the reviewer to stay on track with the flow of the presentation.

5.3.4 Bookmarks

Furthermore, DragonFly is equipped with a bookmark function [D8]. By selecting the bookmark icon from the toolbar, a star icon is put at the current location of the document. The bookmark keeps this location together with the current video time. If the reviewer wants to retrieve interesting parts of the video after some time (e.g., when exams are on the agenda) she can quickly access such positions in time by clicking on the star image in the document. Bookmarks are permanently stored in the document and can be removed or relocated.

Reviewers can add bookmarks to the map.

5.3.5 Notes

Since Fly does not support printing yet, DragonFly allows to put notes, depicted as yellow *post its*, on the Fly map. Thus, a student can put annotations elsewhere on the map and save them with the document. Often, just before exams, students review lectures again and then are reminded of what they have written on the digital notes. These post its can be removed, relocated and resized.

Students can attach notes to the map.

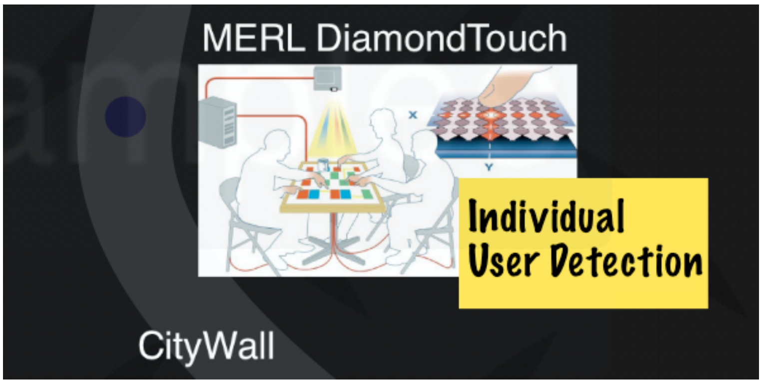


Figure 5.6: A post it. Annotations can be put at any location on the Fly map.

5.3.6 Location Backtracking

Locations visited on the map can be backtracked.

In order to retrieve currently visited locations of the map, DragonFly tracks changes of the document's current perspective.
A forward and a backward button in the toolbar (cf. Figure 5.2, top) allow to skim previously visited locations, similar to backtracking in a web browser. Whenever the map's perspective, i.e., location or zoom level, changes, a timer is started. After a certain time out, the application verifies if the perspective has changed. If not, it is added to the backtracking history.

5.3.7 Quick Stop Navigation

Nearby stops are quickly accessible.

Moreover, quick access to nearby located stops is possible. Dynamic arrows in separate layers at the edges of the document's view indicate the direction of stops which are close to the map's current location. Clicking on the arrow immediately sets the document's perspective to the new stop. This is helpful if the reviewer is interested in material related to the latest stop presented in the video since the idea of Fly is to put coherent information close together.

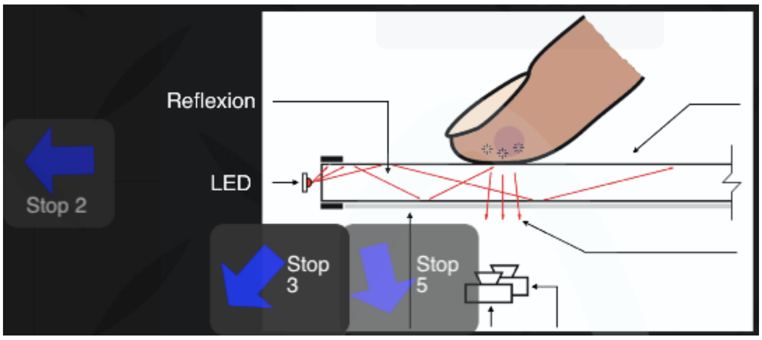


Figure 5.7: Quick stop navigation. Clicking on a bezeled layer with an arrow moves the map's perspective to the stop at the hinted direction.

Chapter 6

Controlled Experiment with Potential Users

After the first design and implementation phase of DragonFly, a controlled experiment with two groups of users was conducted. I wanted to find out whether finding scenes in lecture videos is faster with DragonFly than with an ordinary video player such as QuickTime Player. The results are discussed subsequently to the experiment.

The user study contrasted navigation performance of DragonFly with that of QuickTime.

6.1 Hypothesis

The goal of a user study is to verify the hypothesis resp. to reject the null hypothesis. In the case of DragonFly, the hypothesis is defined as follows:

HYPOTHESIS OF THE CONTROLLED EXPERIMENT:
For a reviewer who has attended a live lecture, it takes **less** time to navigate to a searched-for scene of the appropriate recording using DragonFly compared to Apple QuickTime Player

Definition: *Hypothesis of the Controlled Experiment*

For DragonFly, version Alpha 1 was used. I utilised version 7.6.2, build 518 of QuickTime Player.

6.2 Experiment Setup

A test lecture was held in front of the participants.

The experiment consisted of two sessions. In the first one, I held a 20-minute live talk in front of the testers (cf. 6.3—"Subjects") on the topic of "Multi-touch and Surface Computing". The lecture was held in German, as all study participants are German native speakers. As presentation software I used Fly for DragonFly. A SmartBoard served as both projection display and input source as I touched the nodes on the Fly map while presenting them.

The lecture was captured by video camera.

In addition, the talk was recorded using a Canon HD camera with microphone. To simulate a real lecture situation, the student should behave as usual, e.g., take notes or talk to fellow students during the presentation. The participants could choose one of three identical talks and thus three recordings and three time-stamped documents[1] were created.

The testers were split into two groups.

In the second session, each user individually tested the software herself. Having attended the talk before was mandatory since students normally do not skip the live lecture although a recording is available [Brotherton and Abowd, 2004]. This test was done as between-groups to avoid learning effects which would have distorted results.

The testers had to answer five questions about the test talk with the aid of the recording.

Both groups had to answer five questions about the talk by navigating its recording to the corresponding position. The questions were were not posed in a chronological order so that random video access was achieved. For example, the answer to the first question was explained later in the video compared to the answer of the second question. The questions, posed in the subsequent order, were as follows:

1. What does the abbreviation "FTIR" stand for?

2. What does the term "direct interaction" mean?

3. What is the advantage of capacitive sensors compared to FTIR and DI?

[1]One recording and its Fly document are stored on the attached DVD.

4. How can teamwork evolve from parallel use at a wall display?

5. What is special about the "DiamondTouch"?

Group A worked with QuickTime Player and printouts, group B used DragonFly.

Each user worked with the recording of the live presentation she attended. Group A used QuickTime Player (cf. Figure 6.1) and used a set of printed screen shots of the presentation (cf. Appendix C—"Controlled Experiment Presentation Material") serving as overview of the topic presented. Group B got the DragonFly application to navigate the lecture recording. As usual for DragonFly, the zoomable Fly document was displayed next to the video.

Figure 6.1: QuickTime Player. Group A got QuickTime Player to navigate the lecture recording. In addition, printouts were given to the testers.

The time needed to find the video scene that answered a question was measured.

A question was deemed to be answered when the tester navigated to the appropriate position in the lecture video. I measured the time the testers needed to find the correct scene manually. For group A measurement started when either the tester started to skim the printouts or interact with the player. For group B measurement started with the first interaction with DragonFly. One question was posed after another such that the testers did not know which questions would follow up.

Both groups were equipped with the same hardware, an Apple MacBook 1.1 powered by a 2 GHz Intel Core Duo processor and 1 GB of RAM. Interaction was done via an optical mouse equipped with a scroll wheel.

6.2.1 Independent Variables

All testers got the same questions.

For both groups, the independent parameters of the (second) experiment were the number of questions posed and the questions themselves. Group A worked with QuickTime Player and printouts, group B used the DragonFly application including the presentation document.

6.2.2 Dependent Variables

The users were observed while interacting with the software.

The values measured in the (second) experiment were the time needed to navigate to the unambiguous scene that answered each question as well as the testers' feedback of the software concerning the ease of control and in terms of finding demanded scenes in the lecture recording. Besides, user interaction was manually observed for both groups.

6.3 Subjects

14 students took part in the user study.

A total of 14 students, aged 21-27, 13 male, one female, took part in the study. Group A consisted of seven students, as did group B. Five people were students of computer science. Among them were three who said they were more or less familiar with the topic presented. Two out of the five computer science students were assigned to group A, the remaining three belonged to the DragonFly group. All testers had basic to advanced computer experience and were familiar with QuickTime Player. None of the users has ever worked with DragonFly before. Besides computer science, the testers were students of architecture, medicine, biology, chemistry, mathematics, electrical engineering and geography.

6.4 Results

The questionnaire for the second experiment and a complete version of all figures yield by this study are printed in Appendix D—"Controlled Experiment Questionnaire" resp. Appendix E—"Controlled Experiment Results". The tables presented in this chapter summarise the results.

6.4.1 Navigation Performance

Table 6.1 lists the times the two groups needed for finding the video scene to the appropriate question. Since there were some extreme values (e.g., group B, question 2) for single users, standard deviation values are also given. For each question, the time needed to find a correct scene with DragonFly was shorter[2] compared to QuickTime Player, which means better scores for DragonFly. On average (concerning all questions), a DragonFly user needed 49.66 seconds to navigate to a scene she searched for. This is more than 1.5 times faster than a QuickTime user who needed 78.74 seconds to navigate to the appropriate video position. The median figures yield the same factor: 41.40 seconds vs. 67.80 seconds.

DragonFly users performed 1.6 times faster than QuickTime Player reviewers.

For question 3, arithmetic average and median factors were nearly the same (1.8 vs. 1.9). In the talk, the answer to this question was presented at a stop that had been discussed twice. The first time I presented resistive and capacitive sensors (at the "Multi-Touch Techniques" (MTT) stop). Then I moved on to the stops "FTIR" and "DI" to explain their functionality. Hereafter, I switched back to MTT and contrasted resistive and capacitive sensors with FTIR and DI. DragonFly users clearly had advantage because they could navigate to the same location in the map (i.e., the MTT stop) but select between the two different time modes. QuickTime users had to drag the slider to a distance further[3] away to find the scene in which I had talked about the MTT stop a second time.

The testers did not assume that a presenter talks about one topic at different times.

[2]one exception: For question 1, the median value for both groups is 37 seconds, cf. Appendix E—"Controlled Experiment Results".

[3]compared to the first time position of the MTT stop

	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
A	55.14	45.98	75.71	27.34	130.14	35.04	75.14	34.55	57.57	22.93
B	36.29	3.20	62.43	67.78	70.71	25.00	38.14	7.69	40.71	33.89
B→A	**1.5x**		**1.2x**		**1.8x**		**2.0x**		**1.4x**	

Table 6.1: Average time and standard deviation figures for both groups. On average, DragonFly users performed more than 1.5 times faster than QuickTime users.

6.4.2 QuickTime: Observation and Feedback

QuickTime users worked with printouts first.

While observing the QuickTime users, some general patterns could be derived. Basically, the testers tended to take a look at the printouts before interacting with the video player software. For each question, they skimmed to a matching "slide" and then navigated to the video position showing that stop on the SmartBoard. Thus, the presentation document is important for navigation. Most of the users did not remember that in the live presentation I talked about the MTT stop twice. The testers thought that one stop discussed in the video will not appear again at a later time. This explains the worst performance for question 3 compared to the results of other questions.

Concerning the slider, 58% of group A considered it annoying that they needed to iterate to each scene.

Group A members oriented themselves to faded-in highlights in the video.

Remarkably, all users of group A exploited the highlights set during the Fly presentation for navigation orientation. Whenever an appropriate node highlight appeared in the video, users stopped navigation and played the recording from that position. All members of group A affirmed that navigation without these highlights displayed in the video would have been much more difficult with QuickTime Player and therefore honoured them as very useful. Without printouts, finding the correct scene would have been more difficult again, they confirmed.

The highlights are an affordance for direct manipulation.

Interestingly, two of the users tried to click on a text element of the current video frame displayed in QuickTime Player, hoping that it would set a highlight on the text and forward the video accordingly (*direct manipulation*). This shows that a content-related navigation is intuitive.

Asking group A members for their personal feedback, five out of seven felt that it took a long time until a particular scene was found. In addition, the members complained about missing chapters in the video file which would have been an alternative to large slider jumps.

Navigtion with QuickTime Player was considered uncomfortable.

What the students liked about QuickTime Player was its spartan and easy to use interface. Random visible scrolling was considered useful, especially in combination with the faded-in node highlights.

Random visible scrolling is useful in combination with faded-in highlights.

6.4.3 DragonFly: Observation and Feedback

Observation of the DragonFly users revealed that they needed some time to get used to the concept of DragonFly and its navigation. They got a sample document to explore DragonFly in a five minute session[4].

Working with DragonFly needed familarisation.

Basically, the slider was hardly used among the DragonFly users. For those who worked with this control it seemed to be directly clear that it only refers to the currently displayed stop. However, automatic synchronisation from video to the document sometimes irritated the user. The testers were surprised that the document's perspective automatically changed to a new destination. Furthermore, the testers said that the topic and stop layers covered too much underlying information (cf. Figure 6.2); these should be more transparent.

Video-to-document synchronisation irritated some users.

Location backtracking, bookmarks and notes were never used. For the latter two features, this is due to the nature of the test situation as notes and bookmarks are useful for re-reviewing such that they must be tested in a long-term study. One user asked about these features and said that next to positioning of notes and bookmarks on the map, he wished for all of these items to appear in a vertical list for a better overview.

Bookmarks and notes were never used.

The concept of the heat map failed for the test. Since I talked about each stop nearly the same amount of time, all stops layers got a similar colour.

The heat map did not provide any valuable information.

[4]Karaoke with DragonFly. The sample is available on the DVD attached to this thesis.

Figure 6.2: A stop layer. Concerning the testers, the bluish layer occludes too much of the underlying information.

In addition, a stop's centre, depicted as a coloured bubble which replays the stop, was never clicked by the testers. These bubbles do not seem to have any affordances [Norman, 2002] (cf. Figure 6.3).

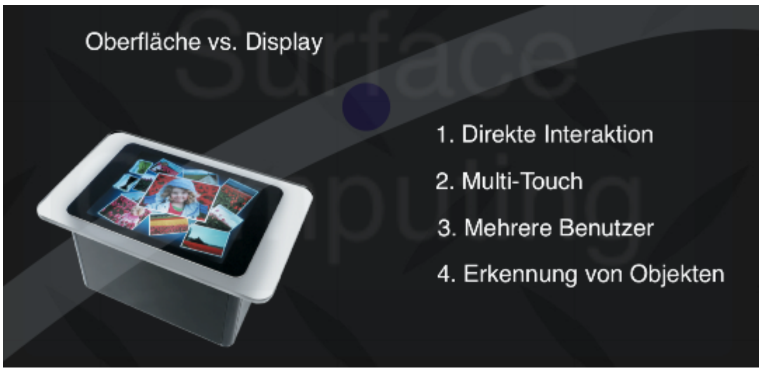


Figure 6.3: A stop bubble. Clicking on the bubble resets the video to the beginning of the stop. Yet, these circles have no affordances for clicking.

The multiple choice circles were not intuitive.

Similar to the QuickTime testers, group B students first thought of a presentation that does not refer to a stop more than once. As for group A, performance results for question 3 were worst for DragonFly (but 1.8 times faster than for QuickTime users). In this context, four out of seven people had problems with the understanding of the intention of the multiple choice circles. They were surprised that at some stops and nodes coloured circles popped up. After having explained that multiple positions in time can be mapped to one location on the map, the meaning of the circles became clear.

What the testers considered extremely useful was the spatial and content-related navigation with the map. Unlike a slider, navigation in DragonFly is dependent on and tailored to the content of the video since for each lecture the corresponding Fly document is used to control the video. The students also appreciated the arrangement of the video and the document next to each other such that it is easy to compare the content of the video with the map. Two members of group B exclusively said that they considered working with DragonFly better and more user friendly compared to a software mainly based on a slider control. Strikingly, one tester even stated that interaction with DragonFly was fun.

Content-oriented navigation was considered extremely useful.

6.4.4 QuickTime Player vs. DragonFly

After the practical part of the second session, the testers were asked to give a ranking for the following questions:

1. The means provided helped me in answering the questions. (ranking from 1 – 4; 1 means "very well", 4 means "not at all")
2. The handling of the software given was:
   easy (1), nearly without problems (2), complicated (3).

The results are given in the table below.

Software	Ranking Question 1	Ranking Question 2
(A) QuickTime	1.86	1.29
(B) DragonFly	1.29	1.43

Table 6.2: Feedback results. The smaller the figure, the better the score.

QuickTime Player was easier to use but DragonFly was considered more useful.

Whereas DragonFly got better scores for finding demanded scenes, QuickTime was considered to be easier to use. This is not astonishing, as QuickTime was familiar to all users and DragonFly was not. Besides, group A did not know any other reviewing software to compare QuickTime with.

DragonFly got positive feedback by all study participants.

At the end of the experiment group A was shown DragonFly and how it worked. All together, group A and group B members confirmed that they consider DragonFly to be more useful and faster to navigate lecture recordings. DragonFly got very positive feedback from all users. Some were even disappointed that they were not assigned to group B after they had seen the application.

6.4.5 Conclusion

DragonFly's timeline slider was hardly used.

The user study revealed that DragonFly testers performed 1.5 times faster in finding specific scenes of a lecture video than QuickTime Player users. Similar results would have come out for analogue players, such as Windows Media Player. The fact that some testers claimed to have foreknowledge about the talk's topic had no influence on the results concerning the figures. As intended by DragonFly's design, the slider was hardly used.

The multiple-times-to-one-location mapping was not immediately understood.

The feedback for the multiple choice circles of DragonFly was not satisfying. However, it must be said that all participants of the study did not expect a double mapping for time to "location". This may be a reason why the multiple choice concept was not immediately understood. Students confirmed that results for QuickTime would have been even worse if no highlights were displayed on the SmartBoard and thus not be recorded since all QuickTime users oriented themselves at the bluish borders. Besides, if the users were more accustomed to the concept of DragonFly and its handling of the zoomable map and the handling of it, group B members probably would have performed faster.

To conclude, DragonFly was considered an extremely useful application in terms of reviewing lecture videos and got positive feedback from all testers.

Chapter 7

Summary and Future Work

7.1 Summary and Contributions

Reviewing lectures is a task done by nearly all students. In this thesis I focused on lecture recordings as review material and hinted at problems reviewers have with navigation using standard video playback software. Applications that try to facilitate navigation for lecture recordings principally work for presentations based on slides. An initial survey helped me to find out which navigation facilities are demanded by students. The results had beared on the design of DragonFly, a reviewing software for mind map-fashioned presentations.

DragonFly is a video navigation software for mind map-fashioned presentations.

In my thesis I presented DragonFly, a software featuring content-related spatial navigation for recorded lectures authored with Fly, a planar presentation tool. In DragonFly, the reviewer is not meant to use a universal control such as a slider, but navigate the recording with the aid of the presentation document, a zoomable mind map. Parts of the video can be forwarded by accessing the corresponding location on the map. Navigation granularity comes at two different levels for coarse and finer steps.
A controlled experiment confirmed that reviewers tend to neglect using a universal slider and prefer working

DragonFly features content-related navigation via the presentation document.

Users neglect making use of the slider.

with controls tailored to the respective lecture. Positive feedback for DragonFly given by the testers showed that they appreciate reviewing by video with the aid of the presentation document next to it.

With DragonFly, students retrieve particular information faster than QuickTime Player.

The hypothesis claiming that reviewers who have attended the live presentation need less time to retrieve specific parts of the lecture video using DragonFly compared to QuickTime Player users could be confirmed. On average, DragonFly users performed 1.5 times faster in the controlled experiment.

Students watching lecture recordings feel a positive impact on their studies.

Although lecture recordings as review material do not automatically lead to better examination results, they have several advantages — such as temporal and local flexibility — for the student. User studies as well as the initial survey revealed that students feel supported by their studies using lecture recordings. My aim was to provide a software that makes finding lecture scenes more comfortable than using standard video controls. The presentation material used by the lecturer is meant to be based on Fly, since planar presentations have several advantages over PowerPoint-like talks.

7.2 Future Work

7.2.1 DragonFly

DragonFly should let the user decide about automatic synchronisation.

Feedback and observations collected from the user study (cf. 6—"Controlled Experiment with Potential Users") were analysed for future improvements of DragonFly.
First of all, some users were confused when DragonFly automatically synchronised the map's perspective to the current video position. In future, DragonFly should let the user decide whether to enable this synchronisation direction or not.
As the testers considered scrolling the map complicated, DragonFly should be adapted to a Google Maps-like[1] handling, which was expected by the users.

[1] http://maps.google.com

There were also complaints about occluding stop layers. In the next version of DragonFly, the layers will be completely transparent but have coloured borders such that the heat map functionality is preserved but underlying nodes are visible.

Stop layers will be transparent.

In this context, the heat map must include further parameters than time only since it failed in the test. I propose to include parameters like node clicks and quantity of multiple access. For instance, a stop that is discussed multiple times needs a significantly higher ranking than stops visited only once. Integrating the concept of social navigation (cf. 3.2.4—"virtPresenter") to the heat map is also imaginable.

The heat map needs more parameters to provide valuable information.

In addition, bookmarks and notes need to be investigated in a long-term study since these tools are meant to be used over multiple review sessions.

Long-term studies must be conducted.

Tackling the problems that occurred with the multiple choice layers is more difficult. Once the concept that one location can be associated with multiple times was explained, the intention of the multiple choice layers became clear. However, the circles must be redesigned in such way that the location-time-mapping becomes clear immediately.

Multiple choice layers need to be redesigned.

Another step is to add direct manipulation support to DragonFly. Testers would like to click on nodes visible in the current video scene to forward the video by content. Finally, a keyword-based search will be implemented in a future version of DragonFly as well.

Direct manipulation and a search function are planned for DragonFly.

7.2.2 Fly

The modified version of Fly (cf. 5.2—"Changes to Fly") has not been tested in a study except by myself. Using a SmartBoard to touch the nodes instead of being dependent on a mouse makes the presentation task remarkably more comfortable. However, such (multi-)touch devices are spacious and expensive. Therefore, an iPhone[2] remote application could display the map and allow touching the nodes with this mobile and more affordable device.

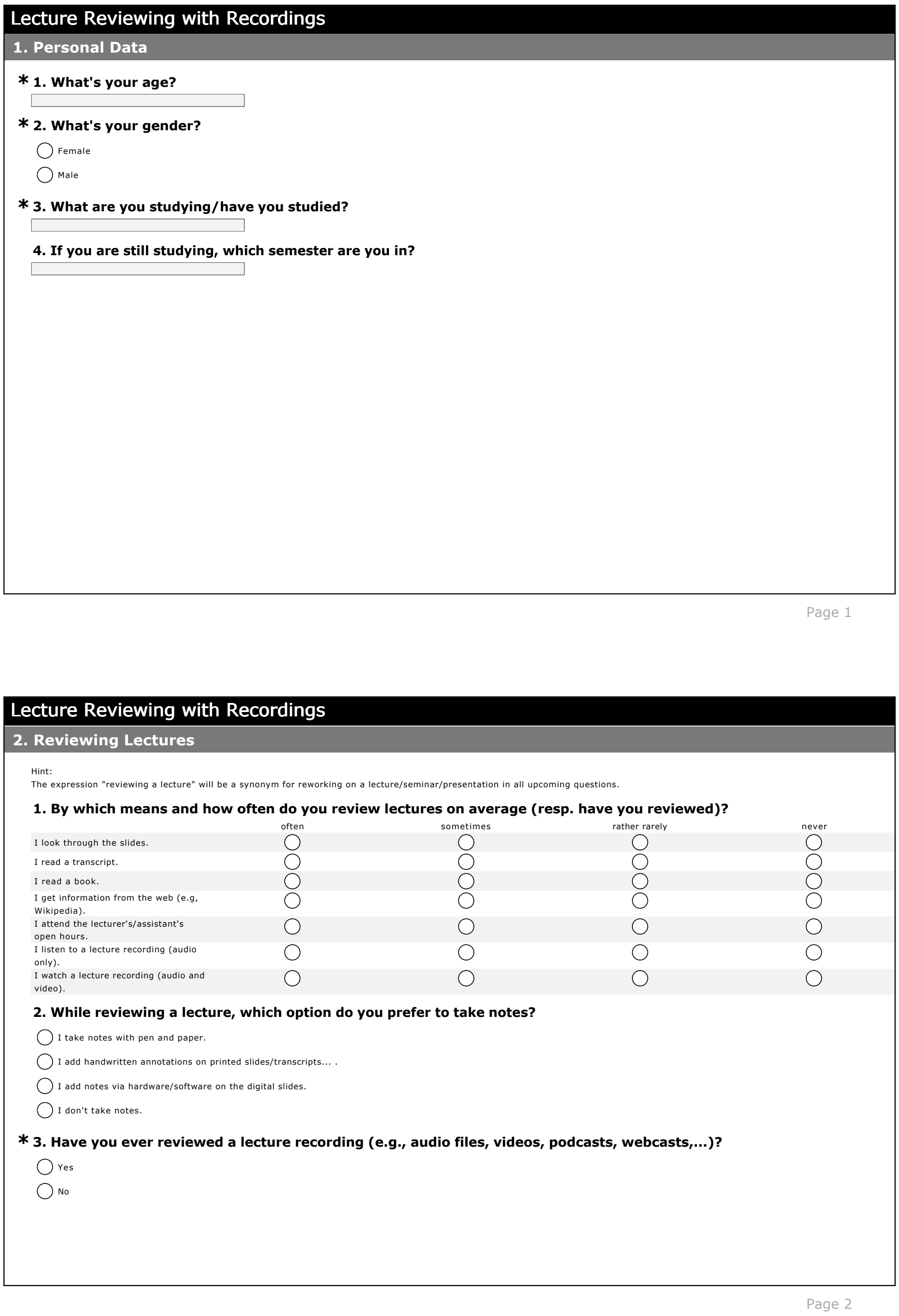
An iPhone version of Fly enables touching nodes without being dependent on a SmartBoard.

[2] http://www.apple.com/iphone

Appendix A

Initial Survey Questionnaire

The following forms were used for the initial survey.
A circle means that there is only one answer allowed for the corresponding question, whereas a square allows multiple answers to one question.



Lecture Reviewing with Recordings

1. Personal Data

*1. What's your age?

*2. What's your gender?

- Female
- Male

*3. What are you studying/have you studied?

4. If you are still studying, which semester are you in?

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Lecture Reviewing with Recordings

2. Reviewing Lectures

Hint:
The expression "reviewing a lecture" will be a synonym for reworking on a lecture/seminar/presentation in all upcoming questions.

1. By which means and how often do you review lectures on average (resp. have you reviewed)?

	often	sometimes	rather rarely	never
I look through the slides.	○	○	○	○
I read a transcript.	○	○	○	○
I read a book.	○	○	○	○
I get information from the web (e.g, Wikipedia).	○	○	○	○
I attend the lecturer's/assistant's open hours.	○	○	○	○
I listen to a lecture recording (audio only).	○	○	○	○
I watch a lecture recording (audio and video).	○	○	○	○

2. While reviewing a lecture, which option do you prefer to take notes?

- I take notes with pen and paper.
- I add handwritten annotations on printed slides/transcripts... .
- I add notes via hardware/software on the digital slides.
- I don't take notes.

*3. Have you ever reviewed a lecture recording (e.g., audio files, videos, podcasts, webcasts,...)?

- Yes
- No

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Figure A.1: Initial Survey Questionnaire (pp. 1-2)

Lecture Reviewing with Recordings

3. Lecture Recordings

1. For what reasons do you review a lecture?

- [ ] To prepare for an exam
- [ ] To work on exercises
- [ ] For making things more clear which I didn't understand
- [ ] To gain insight into upcoming lectures (if I have access to material from former semesters)
- [ ] If I couldn't attend the live lecture
- [ ] So that I do not need to attend the live lecture
- [ ] Other (please specify)

2. Did you benefit from reviewing lecture recordings?

- ○ Yes, I think I got better scores.
- ○ Well, my scores haven't been influenced but I could confirm recently attained knowledge.
- ○ I can't say if I have benefited from it.
- ○ No, it didn't help me.

3. How did you replay resp. access the lecture recordings?

- [ ] Via streaming from a website
- [ ] Downloaded and replayed with a standard audio-/video player
- [ ] Streamed/downloaded and replayed by a designated software for reviewing lecture recordings, called:

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Lecture Reviewing with Recordings

4. Which difficulties/problems/annoyances did you experience while navigating the recording?

- [ ] It took me a long time until I found a certain scene.
- [ ] I had no or limited access to certain contents.
- [ ] None
- [ ] Other (please specify)

5. In your opinion, what should be recorded (video and/or audio recording) in a lecture?

- [ ] The presenter's voice
- [ ] Remarks/questions by the audience
- [ ] The presenter's gestures and facial expression
- [ ] The presentation material, e.g., slides (filmed frame of the video projector; this does _not_ mean adding slides as PDF/PowerPoint/... document!)
- [ ] Other (please specify)

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Figure A.2: Initial Survey Questionnaire (pp. 3-4)

Lecture Reviewing with Recordings

4. Lecture Recordings

1. What is the reason why you haven't reviewed a lecture recording so far?

- ◯ There were no recordings at my disposal.
- ◯ I don't know whether there are any existing recordings of my attended lectures.
- ◯ I think that reviewing a lecture recording is not meaningful.
- ◯ Other (please specify)

2. If there were no recordings at your disposal resp. you didn't know whether some existed, would you have liked to hav lecture recordings?

- ◯ Yes
- ◯ No
- ◯ I don't know.

3. In your opinion, what should be recorded (video and/or audio recording) in a lecture?

- ☐ The presenter's voice
- ☐ Remarks/questions by the audience
- ☐ The presenter's gestures and facial expression
- ☐ The presentation material, e.g., slides (filmed frame of the video projector; this does _not_ mean adding slides as PDF/PowerPoint/... document!)
- ☐ Other (please specify)

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Lecture Reviewing with Recordings

5. Application

1. Imagine you haven't understood a specific topic of the last lecture. Your idea is to review that part with a lecture reviewing system.

How would you navigate to the desired scene in the video?

- ☐ I'd watch the video from the beginning until the desired scene appears.
- ☐ I'd select a topic that deals with the theme I haven't understood in the lecture from a table of contents (a list). The video jumps to the according position immediately.
- ☐ I'd select a topic-related slide from an overview that shows miniatures of all slides. The video will be synchronised with the slide.
- ☐ I'd choose an entry from a list of all bullet points of the slides that sounds familiar with the topic I'm looking for. The video is fast forwarded to the accordant scene.
- ☐ I'd type in some keywords into a search field that deal with the topic. If there are any valuable results, a click forwards the video accordingly.
- ☐ I'd use a timeline slider and move it to the desired video position.
- ☐ I'd use predefined 1-minute jumps to skim the video to the wanted scene.

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Figure A.3: Initial Survey Questionnaire (pp. 5-6)

Lecture Reviewing with Recordings

2. Given are two different interfaces A and B (cf. below).
By clicking on a miniature slide from the overview in A (on the left of A), the video starts playing at that position when the presenter is talking about this slide. Therefore you can only fast forward to such scenes at which the presenter introduces a new slide.
B offers a timeline slider instead of an overview. Moving the slider to the right and releasing it forwards the video and replays it at the current position of the slider. The slide (on the left of B) shows the content the presenter is talking about at all times.

You want to review a specific part of the lecture and roughly know what the slide was about or looked like. Depending on the situation you either (I) don't know how long the presenter talked about the topic, or, remember that the theme was presented in (II) approximately 1 minute, (III) 2-3 minutes, (IV) 3 to 5 minutes resp. (V) more than 10 minutes.

Please specify which interface you would use to navigate the video in the given situations:

	A	B
(I) No idea about duration	◯	◯
(II) +/- 1 minute	◯	◯
(III) 2-3 minutes	◯	◯
(IV) 3 to 5 minutes	◯	◯
(V) More than 10 minutes	◯	◯

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Lecture Reviewing with Recordings

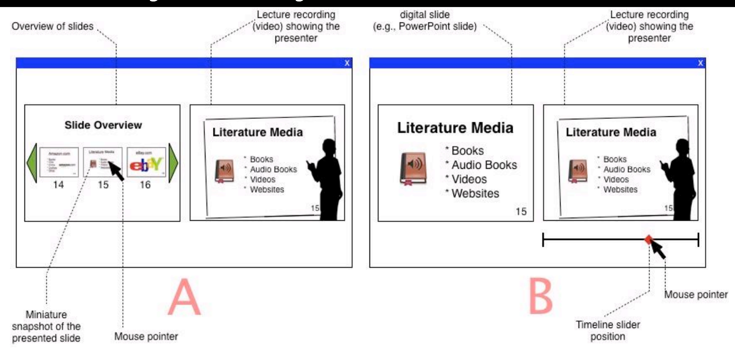

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Figure A.4: Initial Survey Questionnaire (pp. 7-8)

Lecture Reviewing with Recordings

3. Now have a look at the applications C1 and C2 (cf. below). Each of them combines the features of A and B. With the ai of the timeline slider the video can be navigated as follows:

C1. unrestricted navigation: The timeline slider refers to the entire video.
C2. restricted navigation: The timeline slider is restricted to the duration of the presented slide that has been selected from the overview before.

Advantage C1: direct access to each position is possible
Disadvantages C1: accidentally moving the slider beyond the duration of the presented slide is possible + a coarser navigation

Advantages C2: accidentally moving the slider beyond the duration of the presented slide is impossible + a finer navigation
Disadvantage C2: accessing other slides requires to go back to the overview

Which version do you prefer?

- ◯ C1
- ◯ C2
- ◯ I don't know.

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Lecture Reviewing with Recordings

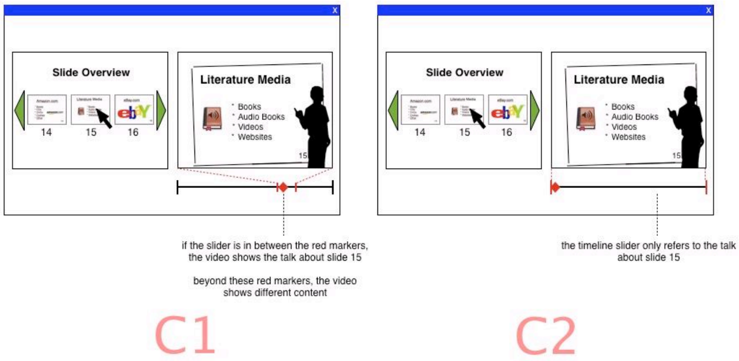

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Figure A.5: Initial Survey Questionnaire (pp. 9-10)

Lecture Reviewing with Recordings

6. Structuring

1. For retrieving parts of the lecture you are interested in, which of the following features would you use for lecture recordings?

- [ ] I'd put resp. access bookmarks.
- [ ] I'd import bookmarks from others (e.g., from fellow students or the presenter).
- [ ] I rely on my memory.

2. Imagine a presenter is holding a talk in biology. First, she gives some information about animals (slides 1-5). Next, she introduces some facts about humans (slides 6-9). Finally, she shows one slide that contrasts animals and humans (slide 10).

In an overview of all slides (1-10), in which order should the miniature snapshots be displayed?

- ○ In the same order as they appeared in the lecture: from left to right or from top to bottom (slides 1-10)
- ○ In the same order as they appeared in the lecture, but it should be visually indicated that the slides 1-5 and 10 plus slides 6-10 are coherent each
- ○ In two different groups: one for animals (slides 1-5, 10) and one for humans (slides 6-10)
- ○ The order is unimportant as long as the miniature snapshots are clearly recognisable.

3. Do you think that a dedicated software for reviewing lecture recordings is useful?

- ○ Yes, it adds valuable features for navigating the content.
- ○ No, a standard audio/video player is completely sufficient for playback.
- ○ I don't like the idea of lecture recordings at all.
- ○ I don't know.

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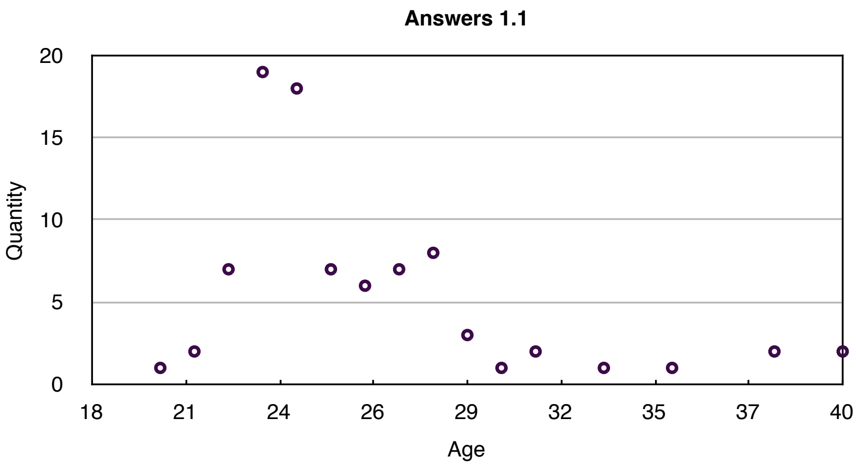
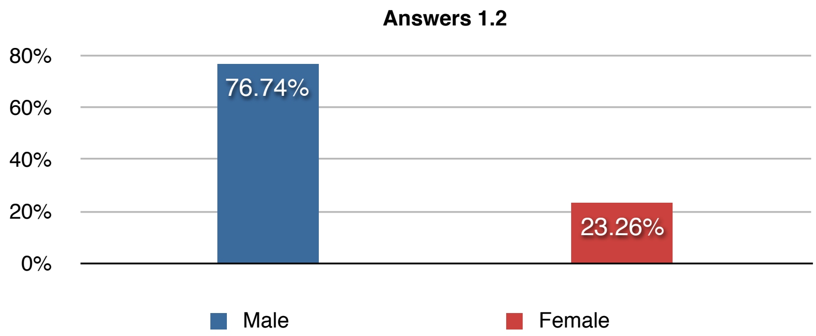
Figure A.6: Initial Survey Questionnaire (p. 11)

Appendix B

Initial Survey Results

The following tables, charts and diagrams show the results of the initial survey. The corresponding questions are printed in Appendix A—"Initial Survey Questionnaire".





Answers 1.3

Subject	Percentage
Technical	37.21%
Social	19.77%
Humanistic	15.12%
Arts	11.63%
Medical	8.14%
Other	8.13%

Figure B.1: Initial Survey Results (p. 1)

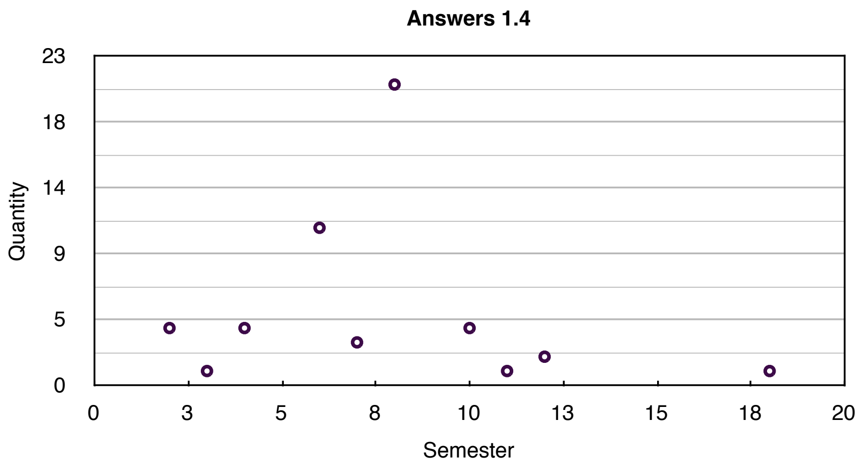
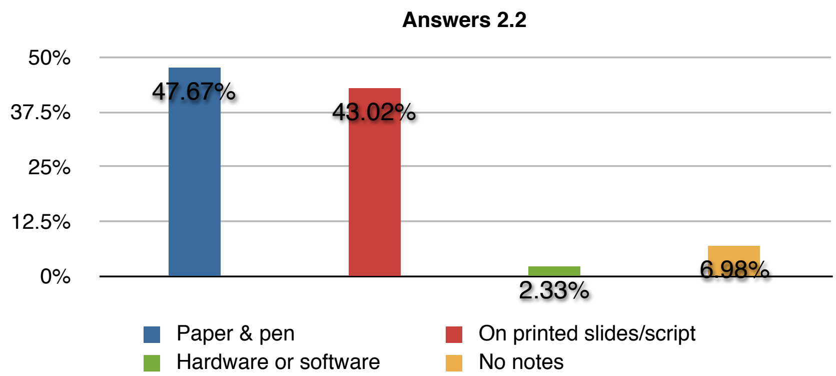


Figure B.2: Initial Survey Results (p. 2)

Answers 2.1

Media	often	sometimes	rarely	never
Slides	50.60%	31.76%	11.76%	5.88%
Script	48.24%	37.65%	11.76%	2.35%
Book	26.74%	39.54%	27.91%	5.81%
Internet	44.71%	29.41%	22.35%	3.53%
Office hours	4.71%	8.24%	31.76%	55.29%
Audio recording	1.20%	6.02%	10.84%	81.94%
Video recording	3.57%	11.90%	19.05%	65.48%



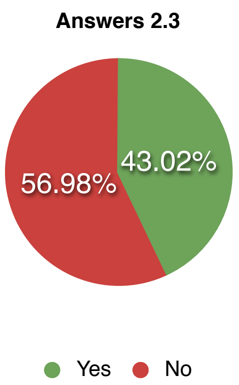
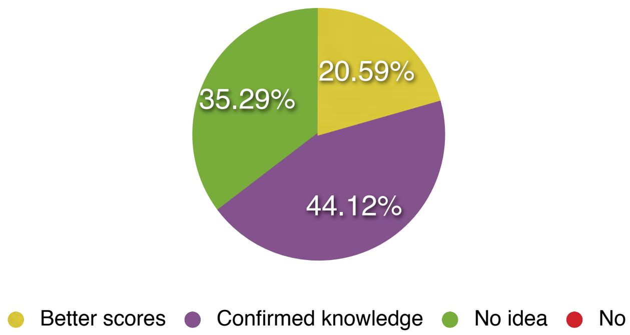


Figure B.3: Initial Survey Results (p. 3)

Answers 3.1

Reason	Percentage
Exams	88.24%
Exercises	44.12%
Questions	50.00%
Preview	23.53%
Missed live lecture	70.59%
Do not want to attend live lecture	14.71%
Other	2.94%

Answers 3.2



Answers 3.3

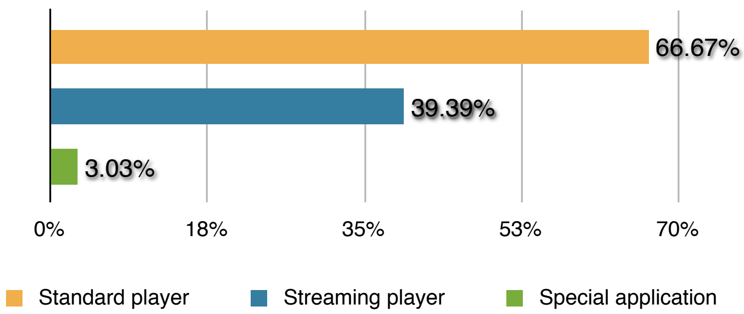


Figure B.4: Initial Survey Results (p. 4)

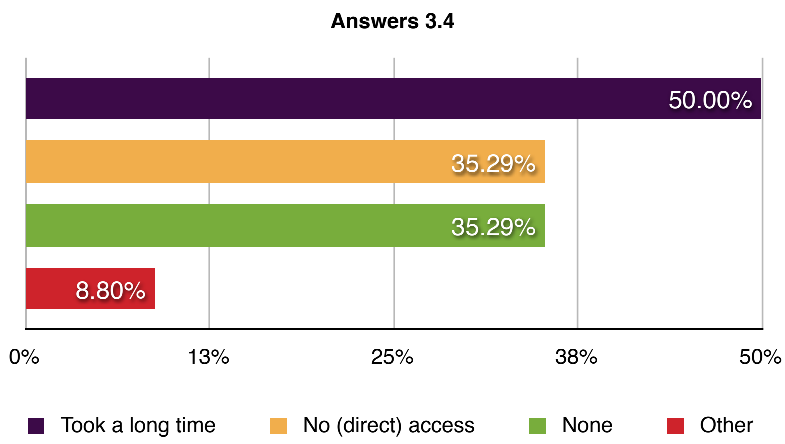
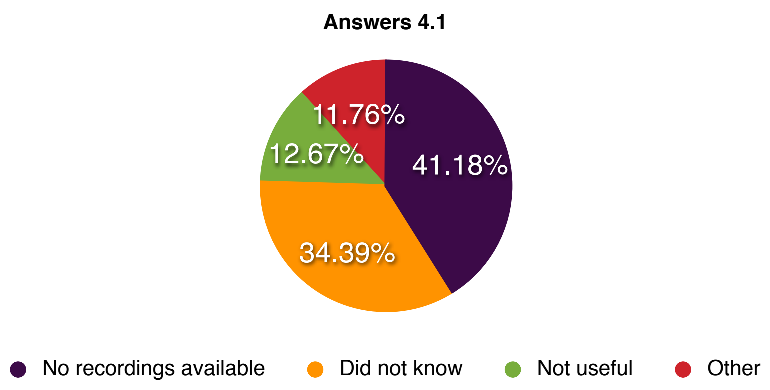
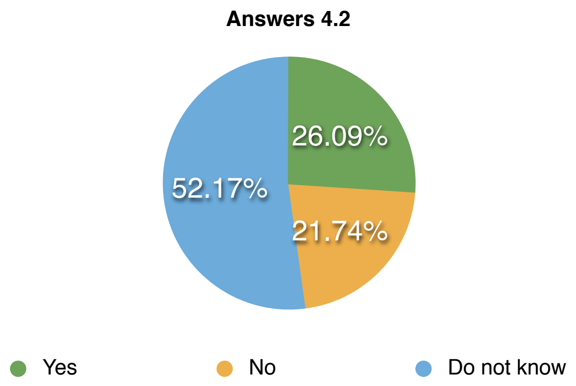


Figure B.5: Initial Survey Results (p. 5)





Answers 3.5 / 4.3

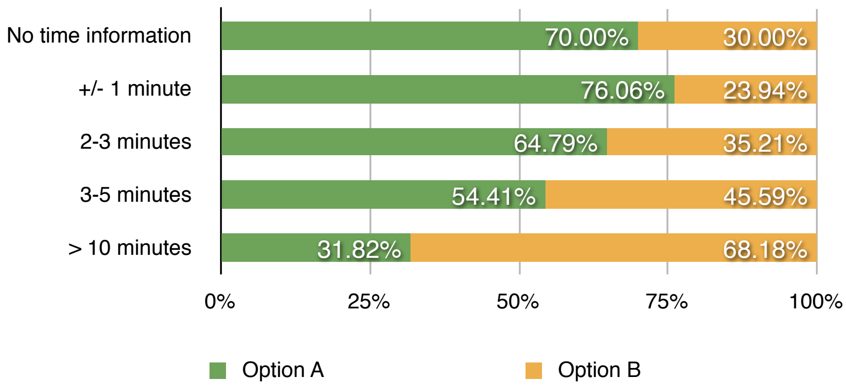
What should be recorded	Percentage
Presenter's voice	92.59%
Audience	60.49%
Presenter's mimic and gestures	29.63%
Projector, whiteboard	79.01%
Other	6.17%

Figure B.6: Initial Survey Results (p. 6)

Answers 5.1

Desired navigation	Percentage
From beginning	5.13%
List	73.08%
Snapshots	48.72%
Bullet points	20.51%
Search	39.74%
Slider	43.59%
One minute jumps	7.69%

Answers 5.2



Answers 5.3

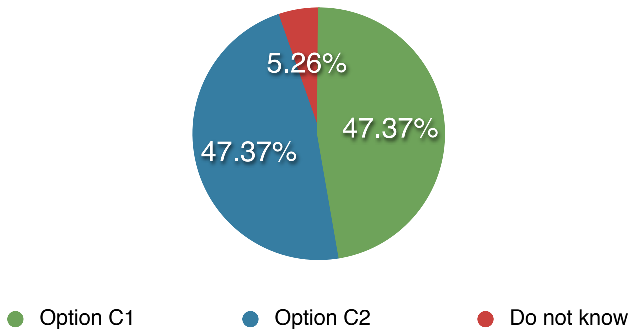
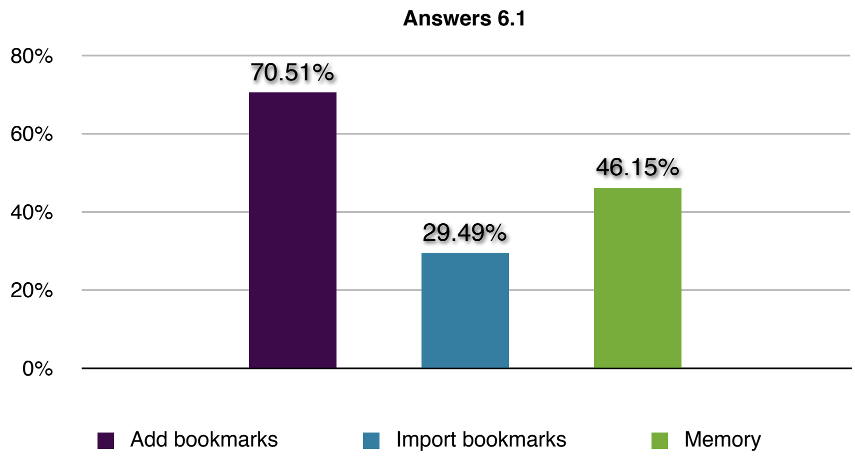


Figure B.7: Initial Survey Results (p. 7)



Answers 6.2

Overview of slides	Percentage
Left to right, top to bottom	92.59%
Visualisation of coherence	60.49%
Different groups	29.63%
Order unimportant	79.01%

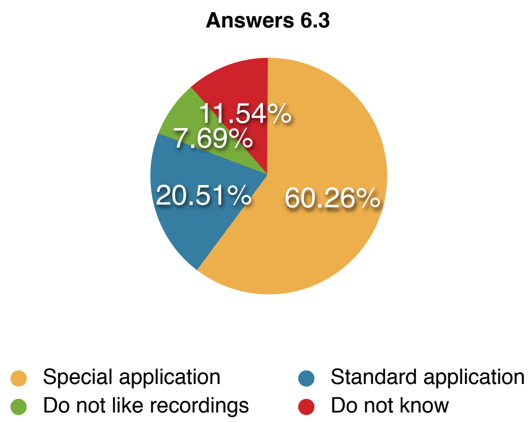


Figure B.8: Initial Survey Results (p. 8)

Appendix C

Controlled Experiment Presentation Material

The following printouts are snapshots of the presentation document on the topic of "Multi-touch and Surface Computing". Participants which were assigned to the QuickTime group got a copy of these snapshots.

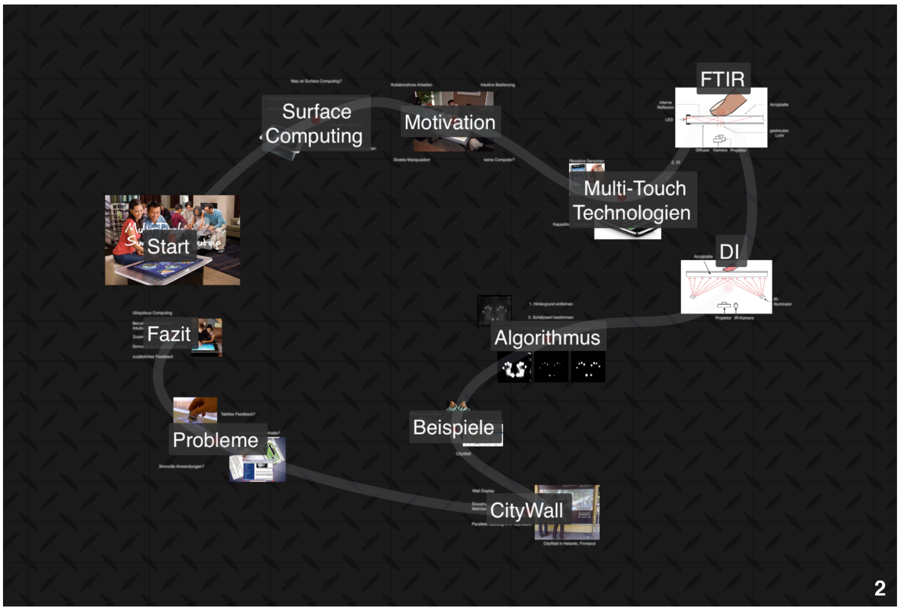


Figure C.1: Controlled Experiment Material (pp. 1-2)

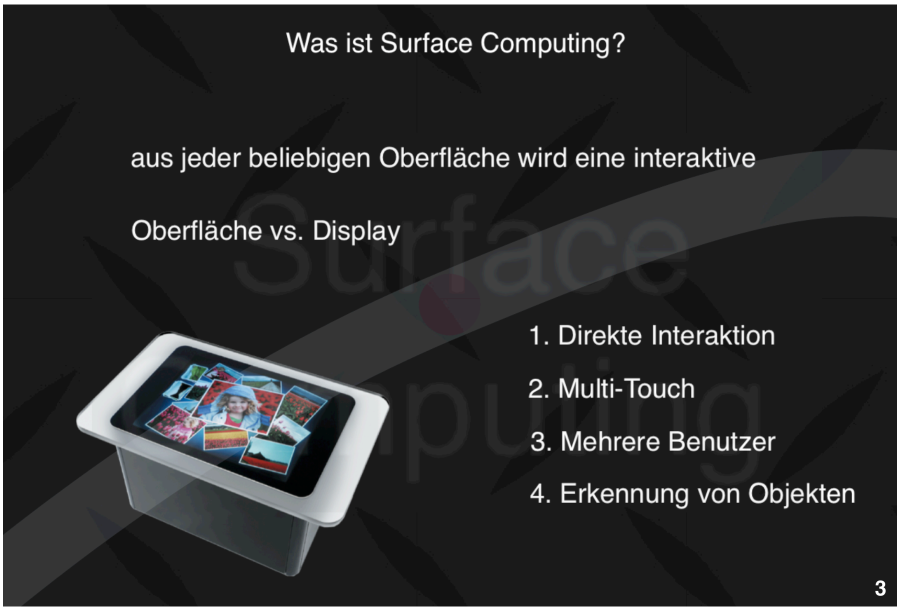


Figure C.2: Controlled Experiment Material (pp. 3-4)

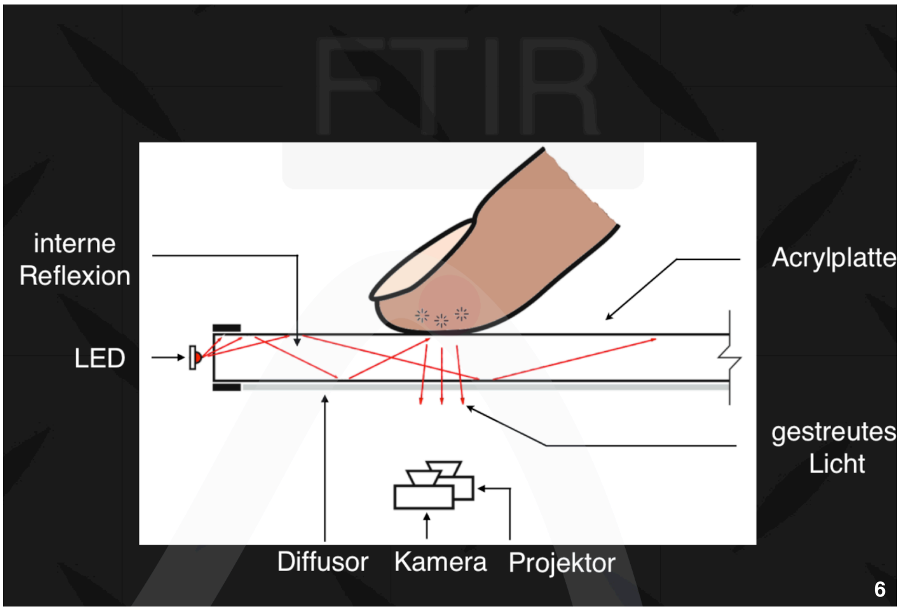
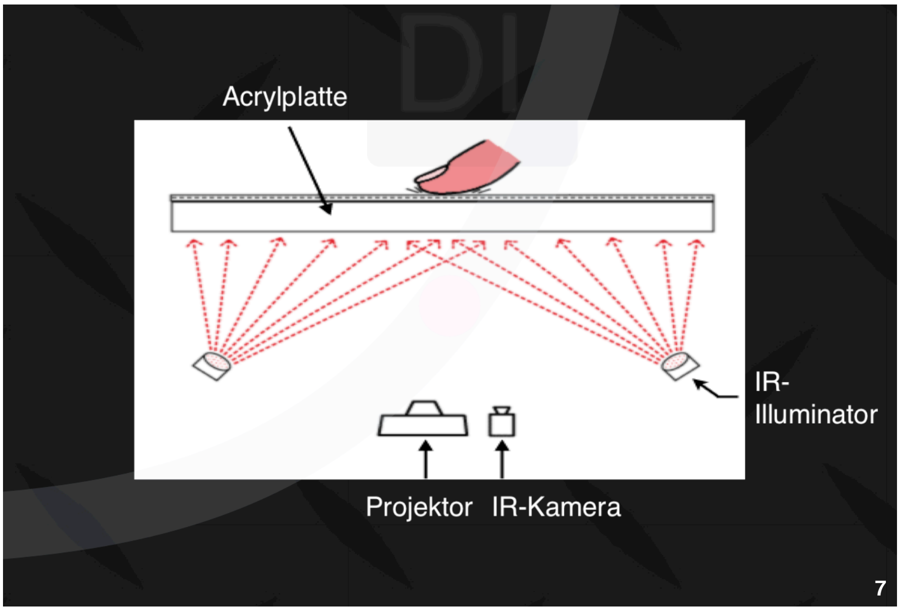


Figure C.3: Controlled Experiment Material (pp. 5-6)



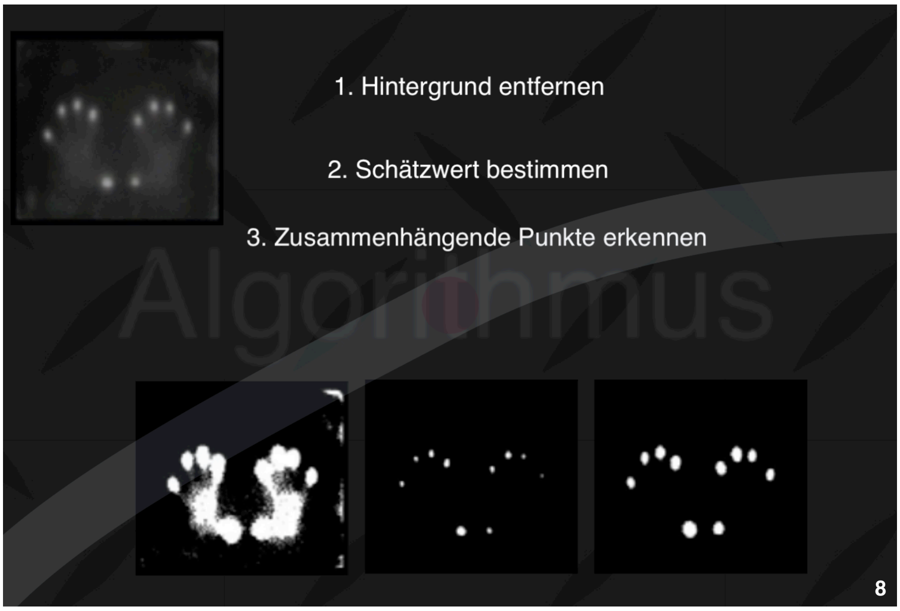


Figure C.4: Controlled Experiment Material (pp. 7-8)

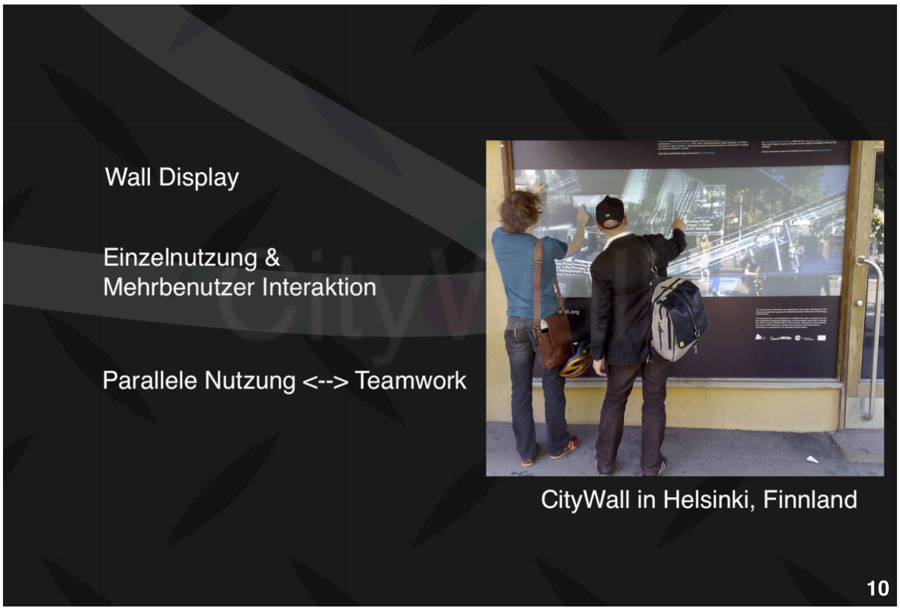


Figure C.5: Controlled Experiment Material (pp. 9-10)

Figure C.6: Controlled Experiment Material (pp. 11-12)

Appendix D

Controlled Experiment Questionnaire

The following questionnaire was filled out in the second session of the controlled experiment. The form has been translated into English. Text elements with grey background have been filled out by myself. All other questions were answered by the participants.

The questions posed in the session were:

1. What does the abbreviation "FTIR" stand for?
2. What does the term "direct interaction" mean?
3. What is the advantage of capacitive sensors compared to FTIR and DI?
4. How can teamwork evolve from parallel use at a wall display?
5. What is special about the "DiamondTouch"?

User test DragonFly - No: _____ - Date: ____.____.____

Application

	☐ QuickTime Player	☐ DragonFly

I hereby agree that my data will be evaluated anonymously for research purposes at RWTH Aachen University. I have been informed that I can quit the user test whenever I want to.

____

(signature)

Personal data:

Sex:	☐ male	☐ female
Age:		
Field of study:		
I had previous knowledge about the topic presented.	☐ yes	☐ no
I took notes.	☐ yes	☐ no
I was distracted during the live talk.	☐ yes	☐ no

Questions about the content of the live talk

Question	Time [sec]
1	
2	
3	
4	
5	

1/2

Figure D.1: Controlled Experiment Questionnaire (p. 1)

User test DragonFly - No: _____ - Date: ____.____.____

Feedback

1. The means provided helped me

☐ very well ☐ well ☐ partially ☐ very little ☐ not at all

in answering the questions.

2. The questions posed in combination with the materials given were:

☐ too easy ☐ fair ☐ too difficult

3. The questions posed were in general:

☐ too easy ☐ fair ☐ too difficult

4. The handling of the software given was:

☐ easy ☐ nearly without problems ☐ complicated

5. What did you not like about the software / Which problems did occur?

____

____

____

6. What did you like about the software?

____

____

____

7. Other:

____

____

____

2/2

Figure D.2: Controlled Experiment Questionnaire (p. 2)

Appendix E

Controlled Experiment Results

The following spread sheet lists the results of the second session of the controlled experiment. The corresponding questions are printed in Appendix D—“Controlled Experiment Questionnaire”.

ID	Age	Subject	Foreknowledge	Notes	Distracted	Rec No.	Application
1	25	Medicine	NO	NO	NO	1	DragonFly
3	27	Comp. Science	NO	YES	NO	1	DragonFly
5	22	Architecture	NO	NO	NO	1	DragonFly
6	26	Comp. Science	YES	NO	NO	1	DragonFly
10	23	Comp. Science	YES	NO	NO	3	DragonFly
12	25	English	NO	NO	NO	1	DragonFly
14	24	Biology	NO	NO	NO	2	DragonFly
2	26	Comp. Science	YES	NO	NO	1	QuickTime
4	21	Medicine	NO	NO	YES	1	QuickTime
7	24	Chemistry	NO	NO	NO	2	QuickTime
8	23	Geography	NO	YES	NO	1	Quicktime
9	24	Electr. Engin.	NO	NO	NO	3	Quicktime
12	24	Mathematics	NO	NO	NO	3	Quicktime
13	22	Comp. Science	NO	NO	YES	1	QuickTime

Figure E.1: Controlled Experiment Results (p. 1)

ID	Time Q1 [sec]	Time Q2 [sec]	Time Q3 [sec]	Time Q4 [sec]	Time Q5 [sec]
DragonFly					
1	33	71	39	31	116
3	41	35	64	40	33
5	39	211	91	50	34
6	32	22	53	39	26
10	37	22	114	40	14
12	37	48	73	26	31
14	35	28	61	41	31
Sum	254	437	495	267	285
Average	**36.29**	**62.43**	**70.71**	**38.14**	**40.71**
σ	3.20	67.78	25.00	7.69	33.89
Median	37	35	64	40	31
QuickTime					
2	154	59	121	57	52
4	34	69	107	120	61
7	19	81	165	53	42
8	37	67	117	60	31
9	39	133	84	129	64
12	35	48	187	42	103
13	68	73	130	65	50
Sum	386	530	911	526	403
Average	**55.14**	**75.71**	**130.14**	**75.14**	**57.57**
σ	45.98	27.34	35.04	34.55	22.93
Median	37	69	121	60	52
Factor Average	**1.52**	**1.21**	**1.84**	**1.97**	**1.41**
Factor Median	1.00	1.97	1.89	1.50	1.68

Figure E.2: Controlled Experiment Results (p. 2)

ID		Feedback Q1	Feedback Q2	Feedback Q3	Feedback Q4
1	DragonFly	1	2	2	2
3		1	2	2	1
5		2	2	2	1
6		2	1	1	2
10		1	2	2	1
12		1	2	2	1
14		1	2	2	2
Average score		**1.29**	**1.86**	**1.86**	**1.43**
2	QuickTime	2	2	2	1
4		2	1	2	1
7		2	2	2	2
8		1	2	2	1
9		1	2	2	1
12		3	2	2	2
13		2	1	1	1
Average score		**1.86**	**1.71**	**1.86**	**1.29**

Figure E.3: Controlled Experiment Results (p. 3)

Appendix F

Digital Content

The attached DVD-ROM contains the source code and the executables of “Fly for DragonFly” and “DragonFly”. In addition, the DVD contains sample material for DragonFly.

At its current development status, DragonFly is **not** compatible with Mac OS X 10.6 Snow Leopard.

The DVD can be found inside the back of the book jacket.

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Typeset October 5, 2009