Two Dimensional Timeline and its Application to Conversant Media System

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Abstract

In this paper, we present a two dimensional timeline to replace the conventional 1D timeline used in video annotation systems. The extra dimension is augmented to represent the text annotations from user input and link them to the corresponding video time. A histogram of user annotations is developed over time. Not only does it highlight the history of prior user interaction with the video annotation system, it also gives a bird’s eye view of how annotations are distributed along the video timeline. Users can then quickly find the hotspots of annotation. Using this unique 2D timeline, we have developed a video annotation system – Conversant Media (CM) for e-learning, with significant improvement in UI over MRAS through our 2D timeline invention, which graphically reveals the distribution of annotations along video timeline and highlights important parts of the video.

In our opinion, both CM and MRAS are niche applications suitable for users who depend highly on video context to conduct their training and discussion.

2. Related work

Microsoft Research has conducted video annotation experiments in the past years, and has developed the Microsoft Research Annotation System (MRAS) prototype [1] [2] [3] [4]. In MRAS, each annotation is anchored to a specific time point (or a range of time) in the video presentation.Annotations are stored external to the video content in a separate database. The separate storage is necessary in allowing users to add annotations without obtaining write access to the video content. As text annotations across multiple sessions persist in the same database, MRAS provides an ideal platform for asynchronous collaboration, where users work at their own convenience.

Based on figures in MRAS publications [2] [3], the UI of MRAS is sketched in Figure 1 below.

![Figure 1. Sketch of MRAS user interface](image)

The MRAS prototype is designed to support annotation of video content in a web browser. The UI consists of four major windows. In the upper left of the browser window is a...
standard media player for displaying video presentation. The upper right window is for presentation slides which are synchronized with the video presentation. In the lower left is the annotation subjects (headers) window: a tree view of the comments, questions, and replies made by previous viewers on the video presentation. Each annotation subject is linked to the specific time point in the video at which the video was paused and the annotation created. The annotation subjects are sorted in chronological order. The lower right part is the annotation preview window, and it automatically displays the text content associated with the annotation subject currently highlighted in the annotation subject window.

MRAS supports the seek feature: the user can click on an annotation subject to read its text content and jump to the point in the video where the annotation was created. MRAS also supports the track feature: as the video plays, annotation subjects scroll by, and the annotation subject closest to the current playing time point is highlighted. Seek and track features link the video and the annotations tightly in a bi-directional way, thus form the navigation foundation of MRAS.

Overall, MRAS can be considered a NNTP news group (text based discussion forum) combined with video context. The MRAS UI however offers users no information on the distribution of the annotations, and the location of hotspots where more annotations aggregate.

3. Two dimensional timeline

In order to overcome the weakness of MRAS, we invented a 2D timeline which can be simply illustrated in Figure 2 below.

![Figure 2. Yellow stickers (annotations) on video timeline](image)

The first dimension is the video timeline. The second dimension is the number of annotations at any specific time point. While watching the video, viewers pause at the selected time points to post their “Yellow Stickers”. A time point that receives many yellow stickers becomes a hotspot where viewers post more annotations. The 2D timeline offers a high level view on how many yellow stickers are posted, how they are distributed and where are the hotspots.

In a video annotation system, there are 2 types of media: primary media and secondary media. The primary media is video (including audio track of the video presentation). The primary media is linear, meaning the video and audio samples are uniformly distributed on the video/audio timeline. Due to this linear property of videos, popular media players (Windows Media Player, QuickTime Player or Real Player) use a slider bar for seeking to desired time points in the video. The content of the primary media will never be changed. The secondary media is annotation text, which is the metadata of the primary media and tightly linked with the primary media. Annotations are not uniformly distributed on the video timeline. The annotations even cluster at some hot points on the video timeline. The number of annotations in the secondary media progressively builds up as the users interact with the annotation system. These two types of media and their different features form the basis of our 2D timeline.

The internal implementation of our 2D timeline is a histogram, which has 300 bins. When a video is loaded into our annotation system, we divide the timeline into 300 segments, each of equal length of time. Then we put the annotations into their respective bins, based on their associated time point. Finally we plot the internal histogram data to the UI as a 2D timeline.

In application UI, the 2D timeline is a sub window with a space-saving size of 30 by 300 dots as shown in Figure 3 on the left. We will explain why the 2D timeline is vertically positioned in next section. We choose yellow as the window background color to suggest Yellow Sticker or Post-it note. Please refer to Figure 5 in next section on how 2D timeline is integrated with our video annotation system prototype. We use a horizontal red hair to replace the slider in conventional 1D timeline. The line width of red hair is only 1 dot, in order to cover less histogram bins.

![Figure 3. The 2D timeline is a sub window with yellow background.](image)

4. Application of 2D timeline to Conversant Media System

With 2D timeline invention as the core component, we have developed a video annotation system prototype: Conversant Media (CM). Conversant means “familiar, as by study or experience”. We implemented CM as client-server architecture, illustrated in Figure 4 below. From the discussion of CM, the unique features of 2D timeline can be elaborated.

![Figure 4. CM system overview](image)
On the server side, there is a file server for storing video files shared by client workstations, and a database server for storing annotation text and other administration information of the CM system, such as user information and video information. Shareware database server MySQL is used to avoid license issues when we conducted the trials.

On the client side, the code is written in Java. We use QuickTime Player as the media player. A wrapper library “QuickTime for Java” provided by Apple is used to glue the CM client Java code and the C code of QuickTime Player library. To access video files on server, clients use standard file sharing through LAN. To access annotations on the database server, clients use JDBC.

The CM main widow is illustrated in Figure 5 below. The upper left part is the media player window. The upper right part is annotation subject window. The 2D timeline is in between these 2 windows.

Since there is no presentation slide synchronized with our trial user’s video clips, we do not need a slide window. This saves a lot of screen space, permitting us to allocate more screen space for annotation subject window, as the users prefer to see more text of annotation subjects.

Several unique UI features of CM are described below.

4.1 Central placement of 2D timeline

The 2D timeline is no longer an integral part of a standard media player. We strategically inserted the 2D timeline between the video window and the annotation subject window, to highlight the role of the 2D timeline which is a bridge to link the two types of media.

4.2 Vertical arrangement of 2D timeline

In MRAS, the slider for 1D timeline moves horizontally, while the highlighted annotation subject moves vertically. This is unnatural. To address this inconsistency, we arranged the 2D timeline vertically along the long dimension (video time point dimension). When the video is being played, both the red hair and highlighted annotations move downwards in parallel.

4.3 Enhanced seek feature

In MRAS, user can click on the 1D timeline to jump to an estimated point in the video. In CM, the 2D timeline provides information of prior user interaction with the video clip. With this information the user can click a single annotation or a hotspot on 2D timeline and the red hair will jump to the clicked point. The video then seeks to the corresponding time point and the annotation or hotspot is highlighted in the annotation subject window. This enhanced seek feature supported by 2D timeline is more precise.

4.4 Enhanced track feature

Figure 6 below illustrates the enhanced track feature of 2D timeline.

The 2D timeline provides a bird’s eye view of all annotations. The annotation subject window is a sliding window to show annotation subjects around the current time point. When the user plays the video, the red hair moves downwards in 2D timeline and annotation subjects around the red hair appear in the annotation subject window as a zoom in view. Users have no precise information on which part of annotations in 2D timeline are displayed in annotation subject window. To solve this problem we added a vertical black bar at the right margin of 2D timeline. The vertical black bar indicates which part of the 2D timeline is being displayed. The black bar moves downward with red hair when the video is played. The dotted lines in Figure 6 do not exist in the real CM UI, but are merely used here to show the relationship between the black bar and the subject window.

5. Experimental results

Between 2001 and 2003, we conducted field trials of CM prototype with the Law School of National University of Singapore and National Institute of Education (NIE) of Singapore.

We purposely chose presentation skill training and performance coaching partners as our trial subjects. We
believe that CM and MRAS are niche applications suitable
for the above partners, which depend highly on video context
to conduct their training and discussion.

5.1 CM trial at the Law School

Presentation skill is crucial to the success of any lawyer. Moot court is widely used worldwide to train law students. Law School decided to use CM as an improved version of moot court. The first CM trial was for freshman enrolled for school year 2002, and student participation is shown in Table 1 below. Each participant or group was shot for several video presentations for about 5 to 10 minutes. He or she then was subjected to the comments of his or her own group, both criticism and appraisal on the presenter’s manner, eye contact, gesture, and presentation organization.

<table>
<thead>
<tr>
<th>Table 1. Student participation of CM trial</th>
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<tr>
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</tr>
<tr>
<td>Students</td>
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<tr>
<td>Video Clips</td>
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<td>Annotations</td>
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The students prefer using the 2D timeline; they can locate the discussion hotspots easily. Lecturers and system administrator also find the 2D timeline useful; they can find the progress of student group directly. After the first trial, law school concluded that CM had helped students improve presentation skills, they continue to use CM prototype for freshman for school year 2003. The video clips and comments from the first trial were used as training materials for the second year.

5.2 CM trial at NIE

The first trial with NIE was during school year 2001. The objective was to assess the merits of using CM in teacher education. An elective course “Instructional Strategies and Effective Learning” was selected for the trial. Twenty five Post-graduate students, divided into 5 groups, participated in the trial. Trainee teachers were asked to view actual classroom video clips and to comment on several aspects of the teaching and classroom management. A survey form of 30 items was then used to collect feedback from trial participants.

NIE published a paper titled “Using Conversant Media as a collaborative learning tool in teacher education” [5] to report the trial results. The paper concluded that “On the whole it can be said that Conversant Media is versatile software to help students participate actively in the learning process. This tool can be specifically useful in teacher education as an alternative means to school visits to see the action in the classroom and conduct discussions. Through this software it is possible to bring the classroom to the computer laboratories of the teacher education institutions and engage the students in powerful learning activities.”

Highly encouraged by the positive response, NIE continues to use CM for school year 2002 and 2003.

6. Conclusions and future works

The 2D timeline proves to be a significant improvement over 1D timeline which was used in other video annotation system. It provides an intuitive graphic representation of the relationship between video and annotations. The 2D timeline is especially beneficial to e-learning environment featuring performance coaching content.

Based on our 2D timeline invention, we have developed our video annotation prototype CM and conducted trials at two educational institutions. After finishing the first year trial successfully, they decide to continue using CM for subsequent years.

The above trial users request to use CM at home. We are considering develop a broadband version of CM to enable users to connect to school server through ADSL or cable modem from home.

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7. References


