A Multi-Scale Timeline Slider for Stream Visualization and Control

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ABSTRACT
We present a new user interface technique for the visualization and playback of long media streams decorated with significant events. Our Multi-Scale Timeline Slider allows users to precisely focus on a specific location in a very long media stream or set of streams based on significant events while also retaining the stream's entire context.

KEYWORDS:
Timeline slider control, multimedia streams, visualization, focus + context.

INTRODUCTION
Applications in automated capture and access for ubiquitous computing generate large amounts of captured streams of information (such as video) and events related to these streams (such as when a particular person in the video is talking). Users often browse the media streams using significant events to help pinpoint an exact location to playback. For example, a user might want to review a series of captured meetings that span a period of 3 months in order to discover what "deadlines" were discussed. This may be accomplished by annotating the video timeline with events marking where the word "deadline" was spoken. Thus, the user requires visualization of such events and control over playback of the stream. Our solution entails a timeline slider that scales time consistently, supports focus + context [2], and allows control over stream playback.

Traditional approaches to controlling media streams usually involve a simple slider. Moving the slider results in moving to a corresponding part in the media. However, this approach doesn't scale well to large amounts of media. One pixel in the slider might correspond to several minutes of media. For streams that are hundreds of hours, one pixel can represent several hours of media!

Submitted for review to UIST '99

To see our widget in action, see:
http://fce.cc.gatech.edu/uist99/mts

We need ways to browse large amounts of media, such as video, yet still have fine control of specific media segments. Infinite focus (and more precise control) can be achieved by using two timelines —one showing the entire media stream, and a second showing a more detailed user-defined subset of the stream. Examples of this are common in video and audio editing programs such as Adobe Premier® and Cool Edit Pro®. In these programs, the only context preserved is the spatial location of the focus region with respect to the entire media stream. This approach does not scale well to timelines that cover large time periods as clusters of events cannot be distinguished and browsed at different levels of granularity.

Other research has explored more novel sliders and timelines. The AlphaSlider [1] is a technique for navigating a large number of ordered objects. However, this technique does not show temporal relationships between objects. TimeSlider [3] provides browsing of a large timeline of events while retaining some context. The slider was built using non-linear context —the time scale in the center is fine and linear but is coarse and exponential on the edges. A non-linear representation of time confuses the context of events by distorting temporal relationships between events. Essentially, the non-linear time gives the illusion that everything in the past (or future) is significant by clustering all of the events into one region.

MULTI-SCALE TIMELINE SLIDER
Our solution, shown in Figure 1, is a multi-scale timeline slider that allows a user to navigate a stream of information and events as well as control the playback of that stream. User controlled, multi-scale zoom is supported through a set of individual timelines that focus the stream context. The user interacts with the timelines by creating focus regions, manipulating existing focus regions, and manipulating the playback control.

Multi-Scale Timelines
The visualization consists of a series of individual timelines, where each subsequent timeline is a focused region of the previous timeline. Each timeline represents a series of ordered streams. The recessed gray rectangles on the timeline, shown in Figure 1, represent a stream. Each

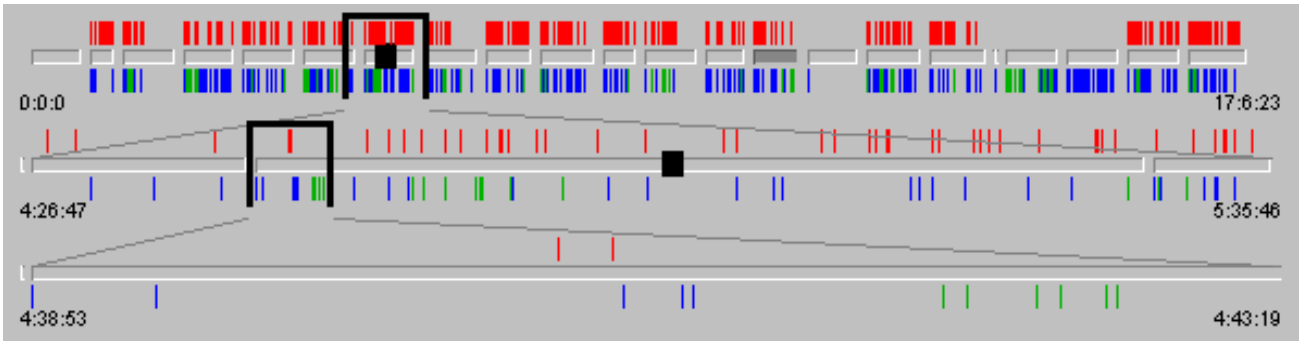

Figure 1: An example multi-scale timeline slider. The focus area on an upper timeline determines the lower timeline range. Events that are clustered in the upper timeline are more sparsely distributed in the focused slider in the bottom.

stream is annotated with events, drawn as colored lines and boxes above and below the stream.

Information is not added as the timeline becomes more focused. However, as focus increases, the individual streams and events spread out and are easier to distinguish.

User-Defined Focus

The focus regions of the individual timelines are completely defined by the user. Right-clicking on a timeline creates a new, subordinate timeline that is a zoomed view of a region of the original timeline. The focus region is represented as the area between two sliding bars. Each bar can be dragged to widen or narrow the region of focus. Additionally, the user can drag the whole region using the top bar of the focus region.

Playback Control

The playback of the streams is controlled through a traditional scrub on the individual timelines. The scrub will appear on all of the relevant timelines. Thus, the scrub is always on the topmost timeline, and appears on the lower timelines when it is in those focused regions. Notice in Figure 1 that the scrub appears on the top and middle timelines, but not the bottom one. Dragging the thumb in a focused timeline allows the user to specify a location in the media stream with greater precision.

DISCUSSION

We have demonstrated the use of this slider in a Java™ application to search a set of lecture audio streams for keywords. This application searches over 17 hours of audio that contain thousands of events representing keyword locations, web page accesses, and slide accesses. Figure 1 was taken from this application. The events above the streams represent keyword locations and the events below represent web page and slide accesses. We intend to use this slider in many of our capture and access applications.

Space is an issue in any information visualization. As this widget is part of a larger interface for viewing streams, we want the widget to take up as little space as possible. Currently, each individual timeline vertically takes up 50 pixels. Thus, as more focused timelines are created, more vertical space will be required. We are investigating user-controlled collapsing of the individual timelines, where the context is visible in just a few pixels but interaction is reduced.

There are several other proposed expansions to this widget. The first is to allow multiple focus regions on each timeline. The next level timeline then becomes a concatenation of those focus regions. This will allow browsing of multiple sections of the timeline at once. The second expansion is to show the temporal relationships between streams instead of just their ordering. This would mean laying out the streams based on their date or time of capture rather than abutting them together.

CONCLUSIONS

We have presented a multi-scale timeline slider for visualization and control of long timelines of annotated media streams. The multi-scale timeline slider provides infinite zoom, a consistent scaling of time and a maintained context of events. This technique allows users to browse events at multiple levels of granularity while simultaneously controlling playback of the streams.

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