Video Browsing on a Circular Timeline

Bernd Münzer ✉ and Klaus Schoeffmann

Institute of Information Technology, Alpen-Adria-Universität Klagenfurt / Lakeside Labs
Klagenfurt am Wörthersee, Austria
[bernd|ks]@itec.aau.at

Abstract. The emerging ubiquity of videos in all aspects of society demands for innovative and efficient browsing and navigation mechanisms. We propose a novel visualization and interaction paradigm that replaces the traditional linear timeline with a circular timeline. The main advantages of this new concept are (1) significantly increased and dynamic navigation granularity, (2) minimized spacial distances between arbitrary points on the timeline, as well as (3) the possibility to efficiently utilize the screen space for bookmarks or other supplemental information associated with points of interest. The demonstrated prototype implementation proves the expedience of this new concept and includes additional navigation and visualization mechanisms, which altogether create a powerful video browser.

Keywords: Video browsing, video navigation, video interaction, visualization

1 Introduction

As recent years show a massive increase in video production and consumption, the issue of efficient video browsing and interaction is steadily gaining importance. The need for innovative user interfaces for efficient and intuitive interaction is undeniable. This is also reflected in the growing popularity of scientific video search competitions [2] [5].

In the last decade, numerous innovative ideas for improved browsing, interaction and retrieval have been proposed [3]. However, most of the proposed interfaces use a linear timeline that is typically located below the actual video and allows the user to navigate in the video. Some approaches augment the timeline with various auxiliary sources of information [1], but so far the timeline always remained linear. The idea of using a circular structure is frequently used for visualization of various kinds of data (e.g., historical timelines or surgical workflow) and has been proposed for indirect navigation support on mobile devices in the form of a *scroll wheel* [6] , but – to the best of our knowledge – has not been considered as basic element for video navigation in a desktop tool so far.

In this paper, we propose a completely new approach for visualization of the video player timeline. Instead of relying on the traditional linear shape, we arrange the timeline around a circle, such that it forms a ring that is superimposed on the video. We argue that this design has a number of advantages over the linear approach. We demonstrate this new concept with a prototype implementation that furthermore includes various useful browsing and navigation features.

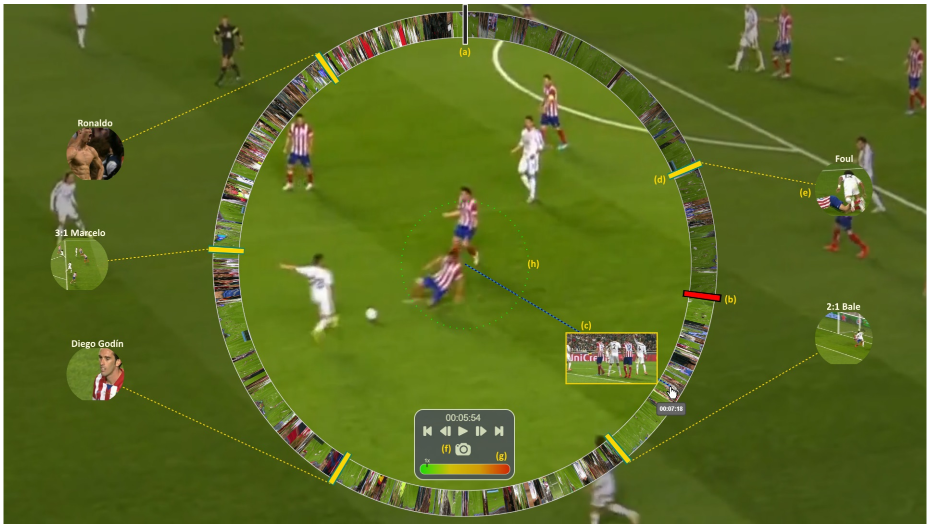

Fig. 1. Screenshot of the user interface. (a) start position, (b) playback progress indicator, (c) preview image, (d) bookmark, (e) bookmark preview image, (f) button for setting a bookmark, (g) speed adaptation pad, (h) minimum center distance for navigation (25% of the radius)

2 Circular Timeline

In the following, we describe the conceptual characteristics and fundamental advantages of the proposed circular timeline, before we provide some details about our implementation. A screenshot of the user interface is depicted in Figure 1.

Intuitive orientation. The circular timeline is arranged in analogy to a clock and therefore allows for intuitive orientation regarding the relative playback time of the current position or various markers on the timeline. The playback progress indicator (Figure 1b) starts at 12 o'clock (Figure 1a) and runs clockwise.

Navigation on the entire screen. Linear timelines typically restrict the used screen region to a rectangular area at the bottom of the screen. By contrast, our circular timeline uses the entire screen as navigation area and thus facilitates much more flexible interaction. This flexibility is due to the mapping from mouse position to video position. It is determined by the angle of the straight line between mouse position and circle center. Hence, the mouse does not need to be positioned on the timeline, but can be anywhere on the screen. In order to visualize the corresponding position on the timeline, our implementation always displays the according line (see Figure 1c).

Navigation granularity. The timeline resolution or *granularity*, i.e., the absolute number of distinct points that can be addressed, is often a limiting factor for precise video navigation. This is particularly relevant in a search scenario where the user wants to find a specific scene in a long video based on a preview image that is visualized in accordance with the mouse position on the timeline. If we assume the common screen resolution of 1920x1080 (FullHD) and consequently an aspect ratio of 16:9, a linear timeline can have a maximum resolution of 1920 pixels, i.e., 1920 distinct preview images can be addressed. With a circular timeline, the granularity is significantly enhanced to 3142 pixels (166%) in the middle of the timeline ring (if we assume a ring width of 60 pixels and a top and bottom margin of 10 pixels, i.e., a circle radius of 500px). Moreover, the granularity is not constant (as for linear timelines), but changes dynamically depending on the distance to the circle center. Coarser navigation can be accomplished by moving the mouse closer to the center, while very fine navigation is possible close to the screen borders (up to a theoretical maximum of 6920 pixels or 360% of linear timeline granularity in the screen corners, where the maximum distance from the circle center can be reached). On displays with a non-widescreen aspect ratio (e.g., 4:3 or portrait mode), the relative gain of granularity is even more significant.

Short distances. A further advantage is that the distances between two arbitrary points on the timeline are reduced. This means that the user can reach other sections of the video with smaller mouse movements. If we consider the timeline ring, the maximum distance between two points is $2 * r$, where r is the circle radius, i.e., 1000 pixels according to the example above. For the linear timeline, the maximum distance is 1920 pixels. However, as the user is not restricted to the actual ring but can also move the mouse towards the center, these distances can become even much shorter. If we consider a distance to the center of $\frac{r}{4}$ (illustrated by Figure 1h), each point on the timeline can be reached within 250 pixels (albeit with lower granularity).

Screen space utilization. Many advanced video players exploit the concept of bookmarks, i.e., markers that either correspond to points of interest or indicate the beginning of a new section and thus help to structure the video into semantic units. Such bookmarks are usually simply highlighted on linear timelines and only show additional information on mouse-over. With a circular timeline, the area left and right outside the circle (or top and bottom in portrait mode) is predestinated for permanent visualization of supplemental information like a preview image, which can be directly linked to the marker on the timeline.

Potential drawbacks. The most obvious potential argument against the circular timeline would be the fact that a certain portion of the video is inevitably occluded. We argue that this problem can be largely mitigated if the circular timeline is not displayed all the time, but only on demand. In our implementation, we hide the navigation ring if the mouse is not moved for n seconds (by default, $n = 1$). A similar strategy is also pursued in many players with linear timelines, but typically with longer time intervals. We deliberately chose a quite short interval due to the higher occlusion extent. Moreover, most relevant content usually tends to be located in the image center and therefore remains visible anyway. Another point could be that this novel interface might be unfamiliar for users and might take a little time to become accustomed. We plan to investigate these aspects in future work with extensive user studies.

3 Demonstration System

We implemented the circular timeline as a web application, i.e., mainly using Javascript at the client and PHP on the server side. The application is currently optimized for usage on a desktop computer, but will also be adapted for mobile devices.

Apart from common playback control, the user can basically interact with the system by (1) moving the mouse anywhere on screen in order to see a preview image of the corresponding video position (Figure 1c), (2) clicking to jump to this position and (3) right clicking on the timeline to add a bookmark (Figure 1d) or other supplemental information. Clicking on a bookmark preview image (Figure 1e) also jumps to the according position. The timeline ring can be configured to visualize various types of automatically extracted information from content-based analysis methods (e.g., scene segmentation) that is represented in a well-defined JSON format. The screenshot illustrates a further automatically extracted element for navigation support: the *Stripe Image* [4], a compact representation of an entire video, which is created by concatenating the center columns of all frames, and provides a good overview of the video content. For instance, in the illustrated soccer example we can clearly distinguish between scenes showing the actual game and scenes showing close-ups. Furthermore, the playback rate can easily be modified by using the *speed pad* (Figure 1g).

4 Conclusions

We present the circular timeline, a novel visualization and interaction paradigm for video navigation. We show that the circular arrangement has a number of advantages compared to the traditional linear timeline and demonstrate the feasibility with a prototype implementation. In our future work we plan to conduct user studies to obtain empirical evidence about the benefit of this approach. We also want to adapt the interface for mobile devices, which will require several different interaction concepts. Moreover, we intend to use this interface for visualization of results from various content based analysis techniques, like temporal scene segmentation or event detection.

References

1. M. D. Fabro, B. Münzer, and L. Böszörmenyi. Smart Video Browsing with Augmented Navigation Bars. In *Advances in Multimedia Modeling*, Lecture Notes in Computer Science, pages 88–98. Springer, Berlin, Heidelberg, Jan. 2013.
2. K. Schoeffmann, D. Ahlström, W. Bailer, C. Cobârzan, F. Hopfgartner, K. McGuinness, C. Gurrin, C. Frisson, D.-D. Le, M. D. Fabro, H. Bai, and W. Weiss. The Video Browser Showdown: a live evaluation of interactive video search tools. *International Journal of Multimedia Information Retrieval*, 3(2):113–127, June 2014.
3. K. Schoeffmann, M. A. Hudelist, and J. Huber. Video Interaction Tools: A Survey of Recent Work. *ACM Comput. Surv.*, 48(1):14:1–14:34, Sept. 2015.
4. K. Schoeffmann, M. Taschwer, and L. Boeszoermenyi. The Video Explorer: A Tool for Navigation and Searching Within a Single Video Based on Fast Content Analysis. In *Proceedings of the First Annual ACM SIGMM Conference on Multimedia Systems*, MMSys '10, pages 247–258, New York, NY, USA, 2010. ACM.
5. A. F. Smeaton, P. Over, and W. Kraaij. Evaluation Campaigns and TRECVid. In *Proceedings of the 8th ACM International Workshop on Multimedia Information Retrieval*, MIR '06, pages 321–330, New York, NY, USA, 2006. ACM.
6. Q. Sun and W. Hürst. Video Browsing on Handheld Devices - Interface Designs for the Next Generation of Mobile Video Players. *IEEE MultiMedia*, 15(3):76–83, July 2008.