Video Traces

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Abstract
Always-on media spaces broadcast video to provide awareness and encourage interaction between collaborators. This video can be captured on the fly as a *video trace*. We created as social visualization system – a variation that blends previous ideas in video editing and video art – that allows people to easily and rapidly explore this video history in detail, ostensibly so they can have a better idea of the activities and availability of their collaborators. However, the system is so effective that it raises significant privacy concerns.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
Always on video media spaces (VMS) provide awareness and encourage interaction between collaborators. Once the subject of esoteric research, both the Internet and the wide availability of inexpensive web cameras now let people easily create their own media spaces.

Normally, countless hours of video are transmitted, but no attempt is made to capture it. If this video is captured and presented as a social visualization, perhaps people can explore this video history in detail, ostensibly to acquire a better idea of the activities and

availability of their collaborators. We call these kinds of visualizations *video traces.*

Yet traditional methods for navigating video - fast-forward and rewind buttons, seek bars - can be overly cumbersome when attempting to look for specific events within such a large video stream. This is especially true where the observer does not know if and when an event has occurred and must manually search through hours of video to find what might constitute only a few seconds of activity. For example, if the media space shows an empty office, the viewer may wish to navigate the history to see if its occupant had been there that day. If so, the viewer may want to see that occupant's rhythm of activity over the course of the day in order to predict when the occupant would return and how busy he or she may be.

Our goal in our video traces project is to explore social visualization designs that allow collaborators to easily explore the history of each other's VMS stream. In this paper we present an example visualization for group awareness called Time Line.

Related Work

Gutwin [3] suggested the idea of *traces* - visualizations of the recent past – as a way to help groupware users increase their understanding of each other's actions. Most of his paper applied the general idea to mitigate jitter and delays in telepointer tracking, e.g., jerkiness is smoothed by reconstructing and visualizing the telepointer trail as motion blur. However, Gutwin also suggested that traces might be used with video to allow for casual awareness, as otherwise people might only glance at a video stream periodically and may miss important events. He included an example sketch of a short-term video trace where several video snapshots taken in the recent past are alpha-blended onto the current video frame.

"When Did Keith Leave?" by Hudson and Smith [4] is a system for casual awareness similar to Gutwin's idea. It portrays a recent history, where it selects and displays several frames from a video stream that shows significant visual differences in activity. Their main focus was not to create visualizations, but to demonstrate how privacy issues might arise as a tradeoff of providing awareness information through a video trace: transient activities of a person are no longer lost if the system extracts and displays significant events. Thus a trade-off arises: while collaborators can benefit by using the system to see each others recent activities and events, it also serves as a (perhaps unintended) surveillance system.

Video slices is a technique used by several researchers to show the passage of a video stream over time. A single video slice is created by extracting a one-pixel wide column from a particular position in a video frame. By abutting columns from successive frames, a cross-section of the video trace over time is visualized as a *video stream.* Video streamer [2], for example, used video slices to create a 3d video block for rapid video editing. Artifacts of the Presence Era, by Viegas et al. [5], was an art installation system that provided a temporal visualization of a video stream of people visiting a museum. The system used a rock formation metaphor to construct the visualization. Layers were added to the visualization by periodically taking slices from video frames. As new layers were added to the top of the visualization, older layers were compressed by combining multiple frames and replacing them with

the resulting image. Visitors could navigate and uncover past images in the visual history by turning a knob. Similarly, the Last Clock by Angesleva and Cooper [1] used video slices to populate a visualization resembling the face of a clock. As the hands moved around the clock, the current (rotated) video slice replaced the underlying portion of the clock face.

The focus of most video visualization projects were geared towards visualizing the passage of time. Our own interest took this one step further: how collaborators could find and understand the detailed activities and events occurring within the video stream.

Time Line

We developed a visualization of a video history called Time Line that lets people interactively find and explore detailed events within a large video stream. Time Line replicates and extends ideas found in Artifacts of the Presence Era [5] and the Last Clock [1]. It too creates composite images by periodically adding video slices. Because this is done continuously, the running visualization gives observers a sense of the dynamics of the space along the column boundary. Somewhat similar to the Last Clock [1], a timepiece is created by using multiple rows to show the last minute, hour, day, or week of video. Figure 1 illustrates the visualization of these time periods running after several hours; the last minute (top row), the last hour (middle row), and the last day (bottom row). The week line is not shown in this figure. The real-time video stream, shown at the bottom left of Figure 1, is displayed within a floating window.

One difference from previous systems is that a person can interactively adjust the focus onto a particular column of the video frame by adjusting the slider at the bottom of the floating video window: as this is done the entire visualization is immediately updated to show that view.

While the visualization as shown in this static image may appear difficult to understand, a person viewing the actual system quickly learns how to read the visualization and how to interpret its perturbations. For example, Figure 1 shows that the slider in the floating video window is set to a column on the middle-left side of the scene. The top row illustrates changes in that column over the last minute: we see that one person wearing a purple shirt was in that area for about 10 seconds. In the hour view (second row), we see various activities – some short, some long - interspersed within extensive periods of inactivity. While people are coming and going, we see that one group lingered in the area for around 5 minutes.

Another significant improvement over prior systems is that Time Line allows very rapid detailed exploration of this video stream: A person simply clicks and scrubs over the visualization, and Time Line instantaneously retrieves the image under the cursor and displays it within the floating video window. If the person does this within the most frequently updated minute line, it will display the finest grain of video replay. For example, if a person rapidly scrubs back and forth over the person visible in the minute line, she will see him perform his action repeatedly at high speed. Conversely, the infrequently updated day or week lines provide only course grain video replay; the video stream represented in these lines may miss quick events occurring between updates. Still, if the person scrubs over (say) the left-most disturbance in the hour

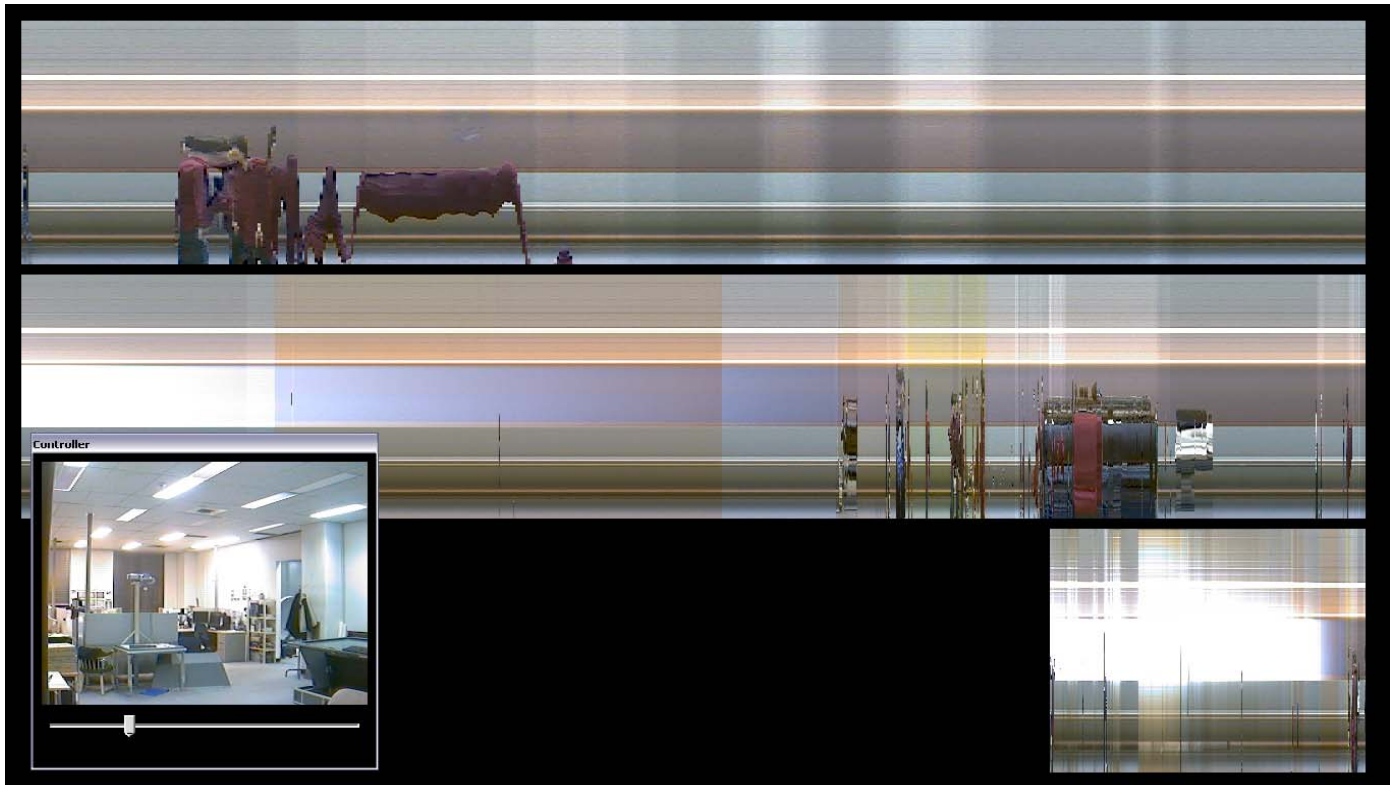

Figure 1: Example of the time line visualization; the camera is currently oriented to view into a public laboratory space.

line, she will see who it is and roughly what he is doing. This interactivity also helps people learn how to interpret perturbations in the scene.

The time line visualization is exceptionally powerful in that it can represent a large amount of video data, and that it provides an easy means to navigate and explore the stream in detail. There is no question that it provides information that serves as a social visualization of presence and activity awareness.

However, it is also a very scary system. Its very power raises significant privacy issues. We cannot predict where this visualization will be best suited. Perhaps it would work well in an area that is largely accepted as public, rather than in a personal office or workspace. Or perhaps it would work well between intimates with a strong need and desire to stay connected. Or perhaps it would be appropriated for security and surveillance, where large amounts of video data might be searched to discover illicit activities and events.

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