VIDEO BROWSING USING MOTION VISUALIZATION

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ABSTRACT

We present a video browsing tool that uses a novel and powerful visualization technique of video motion. The tool provides an interactive navigation index that allows users to quickly and easily recognize content semantics like scenes with fast/slow motion (in general or according to a specific direction), scenes showing still/moving objects in front of a still/moving background, camera pans, or camera zooms. Moreover, the visualization facilitates identification of similar segments in a video. A first user study has shown encouraging results.

Index Terms— Video Browsing, Video Navigation, Video Indexing, Motion Visualization, Video Exploration.

1. INTRODUCTION

Video browsing is known as the interactive process of quickly navigating through the content of a video, without having any specific query in mind, in order to (1) get a quick overview of the content and to (2) find out where potentially interesting segments are located. A remarkable amount of research has already been done in that area (some recent work is summarized in [1]).

We present a novel video browsing tool visualizing video motion by color. Motion information is extracted from compressed H.264/AVC videos and mapped to the HSV color space such that motion direction and intensity statistics become visible by color and brightness variations. After a short training phase, the user is able to map certain low-level color patterns to semantically valuable high-level patterns, enabling the efficient identification of potentially interesting video segments. Some domain-specific examples of mapping low-level motion characteristics to high-level semantic patterns are:

- In surveillance use cases, video segments with large or fast moving picture areas that interrupt segments with slow or still motion are potentially interesting.
- For news videos, segments with dominant still motion will probably show the speaker in front of a stable background.
- All jump-off scenes of a ski-jumping video exhibit similar motion characteristics visualized by similar color patterns that can be easily recognized.
- Dominant motion to a single direction (visualized by a single color) or to all directions (multicolored) may be caused by camera pans or zooms, respectively. Identification of such video segments could be useful not only for cutting use cases, but also in application domains where similar camera motion occurs frequently. For example, in the quiz show series *Who Wants To Be A Millionaire* the *Ask The Audience* lifeline can be easily recognized by looking for a certain camera motion pattern.

Our video browsing tool supports the training phase by interactive video navigation within motion diagrams. Moreover, mnemonic names (such as ”jump-off” or ”zoom”) can be assigned to the motion statistics of video segments and stored for later use by a retrieval application. The simple user interface based on well-known interaction models has been evaluated by a first user study [1], which has shown that non-expert users can intuitively understand it and find similar scenes significantly faster than by using a standard video player. The latter is still commonly regarded the poor man’s video browsing tool.

2. MOTION VISUALIZATION

We proposed a classification and visualization scheme of video motion [1] allowing a user to quickly perceive the following properties of video segments, as determined by the video encoder: (a) the relative amount of moving and not moving pixels, (b) the relative amount of pixels moving in a particular direction interval, and (c) the median motion intensity (fast or slow). Moreover, a user is able to identify video segments with similar object or camera motion due to similar visualization, even without fully understanding the visualization scheme [1]. The visualization example shown in Figure 1 shows a camera pan, two zooms, and video segments containing only little and slow motion for a news video.

The visualization scheme operates on frame-based *motion histograms* with bins $b \in \{0, \ldots, K\}$, which collect statistics

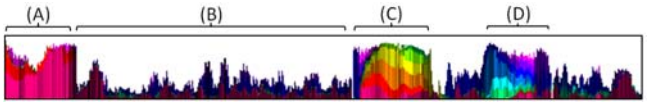

Fig. 1. Visualization ($K = 12$) applied to 25 seconds of a news video. The numbers denote scenes as follows: (A) fast approaching car from the right (pan left), (B) an interview (with small amount of slow motion), (C) fast zoom originating from right above, (D) fast zoom originating from bottom left.

about motion vectors extracted from an H.264/AVC encoded video stream. Each bin $b > 0$ represents a certain motion direction interval; bin 0 is used for zero-length motion vectors only. The numbers stored with each histogram bin b are: (1) the relative amount D_b of pixels within a frame being predicted by a motion vector of bin b (*motion direction* statistics); and (2) the median length I_b of all motion vectors of bin b (*motion intensity* statistics). For details see [1].

The motion histogram of a frame is visualized by a single vertical line consisting of $K + 1$ line segments, each segment L_b related to a certain histogram bin b. The length of L_b is directly proportional to D_b, and its color is computed in the HSV color space: the H value is derived from the motion direction represented by b, S and V values are related to motion intensity I_b such that more intensive (faster) motion is depicted by brighter colors. However, bin 0 (no motion) is represented by a white line segment. When arranging the vertical lines of consecutive frames horizontally, the visualization of video motion as shown in Figure 1 is obtained.

3. USER INTERFACE

Figure 2 shows the user interface of our video browsing tool, which consists of three areas: (1) the content view at the left showing the video frames and a simple time-slider, (2) the motion visualization panel at the bottom of the screen, (3) a preview panel showing low-quality preview pictures and the related playback time according to the (last) mouse-position on the motion visualization panel.

The motion visualization panel consists of two diagrams, namely an *overview diagram* and a *detailed diagram*. As shown in Figure 3, the overview diagram visualizes the motion for all n frames of a video and contains a *zoom window* that defines the temporal segment (of k frames) for which the details should be visualized in the detailed diagram below. The user can move and resize the zoom window within the overview diagram, where any change immediately affects the detailed diagram. The concept of overview diagram and zoom window preserves the browsing context of the detailed diagram.

The zoom window in Figure 2 (4) has been chosen such that the detailed diagram appears with maximal temporal resolution. The preview panel also shows the hue circle (5) of

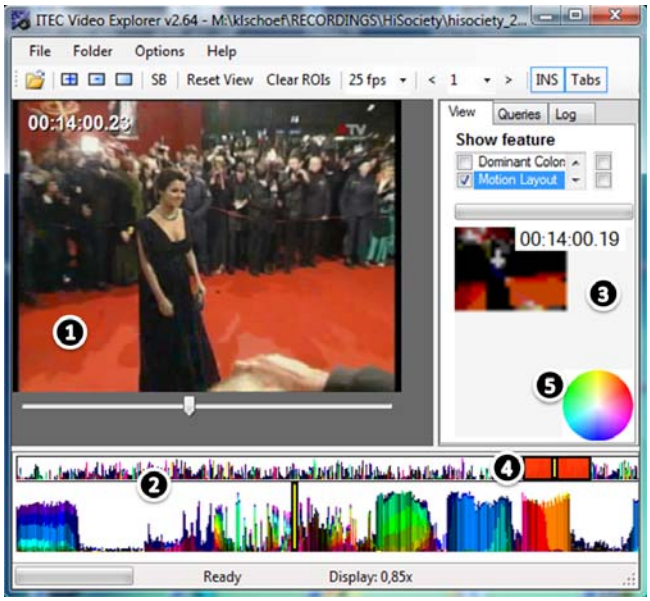

Fig. 2. User interface

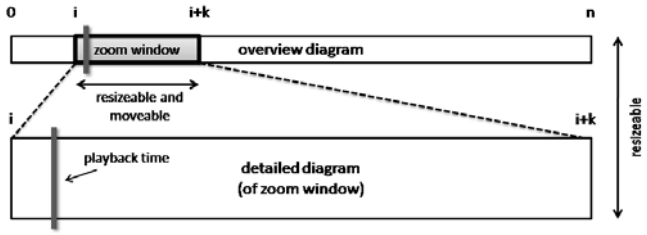

Fig. 3. Interaction model of the visual navigation index

the HSV color space representing the color mapping of motion directions as explained in Section 2.

4. CONCLUSION

The presented video browsing tool uses a novel visualization of motion histograms computed from motion vectors of a compressed H.264/AVC video stream, which is a low-complexity task, because it does not require full video decoding. The visualization maps motion direction and intensity to color and brightness variations and enables users to associate low-level motion patterns with high-level content semantics of video segments. After a short training phase, the tool can be used effectively to find potentially interesting or similar video segments.

5. REFERENCES

[1] K. Schoeffmann, M. Lux, M. Taschwer, and L. Boeszoermenyi, "Visualization of Video Motion in Context of Video Browsing," *Multimedia and Expo, 2009. ICME 2009. IEEE International Conference on*, July 2009.