# A Key-Frame-Oriented Video Browser

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**Abstract.** We propose a video browser facilitating known-item search in a single video. Key frames are presented as four images at a time and can be navigated quickly in both forward and backward directions using a slider. Alternatively, key frames can be displayed automatically at different frame rates. The user may choose between three mappings of key frames to the four key frame widgets based on video time stamps and color similarity.

## 1 Introduction

Video browsing is the task of efficiently navigating through a video in order to quickly arrive at one or more video segments of interest. A typical use case is a person trying to find a particular scene in a movie she had watched a few months ago. This *known-item search* task is different from the equally named problem of finding a particular video within a large video collection [2].

Common digital media players provide VCR-like controls only, making the known-item search task often a time-consuming and wearisome effort. Efficient navigation through a one-hour video requires alternative representation and interaction models. Meaningful reduction of presented visual data and a more flexible way of browsing them are needed.

We propose a video browser tool supporting these needs in a simple, but hopefully efficient way: visual data are reduced to key frames, which are presented to the user as four images at a time. Because all key frames are kept in memory, navigation through them happens quickly both in forward and backward order. The efficiency of this approach relies on the human ability to quickly recognize visual patterns in parallel and on the technical ability of immediate key frame display control.

## 2 User Interface

The user interface of the proposed video browser is shown in Figure 1. Each of the four image widgets near the top displays a subsequence of key frames ordered by time stamp. The combo box above them allows to choose between three construction methods of these subsequences: (a) *time slice:* the sequence of all key frames is partitioned into four subsequences of consecutive key frames

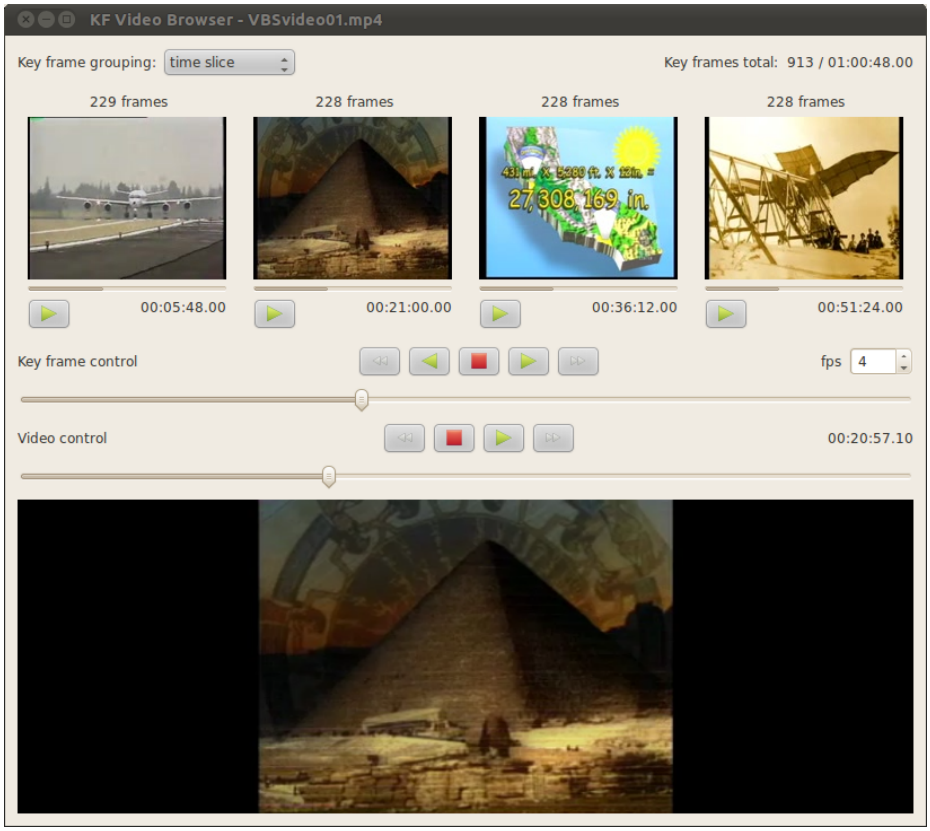


**Fig. 1.** User interface of the proposed video browser. The top four image widgets display key frames only, the bottom widget represents a traditional video player.

of approximately equal length. That is, the first key frame widget shows only key frames taken from the first quarter of the video, the second widget shows only key frames taken from the second quarter, and so on. (b) *sequential:* each key frame widget displays all key frames, but with different starting offsets such that four consecutive key frames are visible at the same time. When sliding through key frames, the same key frame virtually moves over all four widgets, giving it a higher chance to be recognized by the user. (c) *color similarity:* the set of all key frames is partitioned into four k-means clusters with respect to 13-dimensional color feature vectors. Within each cluster, key frames are sorted by time stamp and the resulting subsequence is assigned to a single key frame widget. Obviously, the number of key frames per widget may vary significantly.

The upper one of the two sliders is the key frame control slider, which simultaneously affects all four key frame widgets. Dragging the slider to the right gradually displays all key frames assigned to each widget – possibly at different frame rates depending on the number of key frames per widget. In addition

to manual slider dragging, the slider can be operated automatically using the VCR-like controls above. The maximal display frame rate per widget can be chosen from a range between 2 and 20 fps. The *step backwards* and *step forward* buttons (double arrows) move the slider by 5% of the slider length.

The *play* button below each key frame widget allows to start video playback at the time stamp of the key frame, using the traditional video player in the lower part of the user interface.

## 3 Known-Item Search in Video

Depending on the particular video segment that is to be found, different key frame grouping methods may be preferred: (a) If the video segment contains a striking color structure, the *color similarity* grouping will be most effective, because the segment will be contained in a rather small cluster. (b) If the video segment is represented by only a few key frames, the *sequential* grouping may be beneficial, because the same key frame will be displayed in all four key frame widgets at different times. (c) Otherwise, the *time slice* grouping provides a good starting point as all key frames can be displayed by scrolling through only a quarter of them.

From a user's perspective, bidirectional navigation in the key frame sequences is important, because human reaction to recognizing a key frame of interest usually involves a certain delay.

## 4 Key Frame Preprocessing

Key frames are extracted after shot boundary detection [1]. To facilitate searching for short video segments, the extraction rate is adapted to shot length, varying between 1 fps for shots shorter than 4 seconds, and 1/6 fps for shot lengths of at least 20 seconds.

Feature extraction for color similarity clustering is based on color histograms with 12 bins. Every pixel is assigned a probability vector of 11 well-known color names [3] and its lightness value in CIELAB color space. The normalized sum of these vectors over all pixels of an image constitutes a key frame's feature vector.

## References


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