

Video Summarization Preserving Dynamic Content

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Approach

- Minimize task-specific components
- Handle camera-motion segments separately
- Filter non-interesting segments
- Keep non-redundant segments with motion
- Computationally expensive features need to add significant value
 - Face recognition (OpenCV) was slow, low-accuracy
- Presentation easily understandable

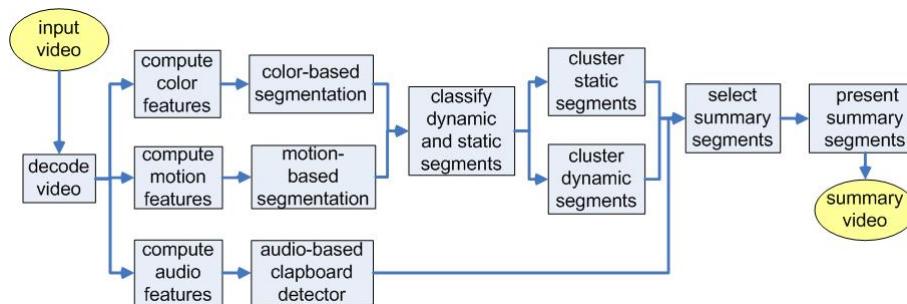
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Outline

- Approach
- System
 - Static and dynamic camera
 - Audio clapboard detection
- Evaluation
- Summary and Conclusions

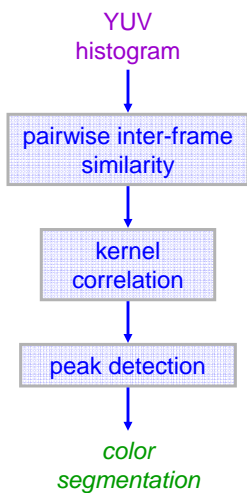
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System Overview

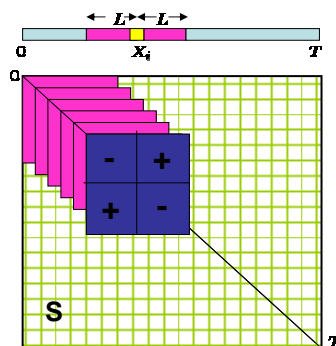


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Color-based Segmentation



- Inter-frame similarity: chi-squared histogram distance



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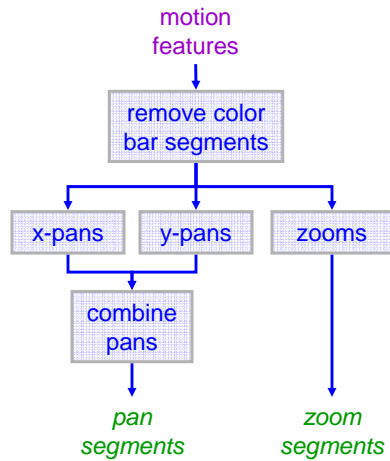
Motion Features

- OpenCV
 - cvGoodFeaturesToTrack
 - Lucas-Kanade point tracking
- Features
 - histogram of motion magnitude
 - x, y, radial component of low-magnitude vectors
 - mean and variance

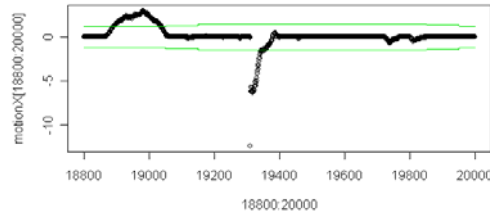


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Motion Segmentation

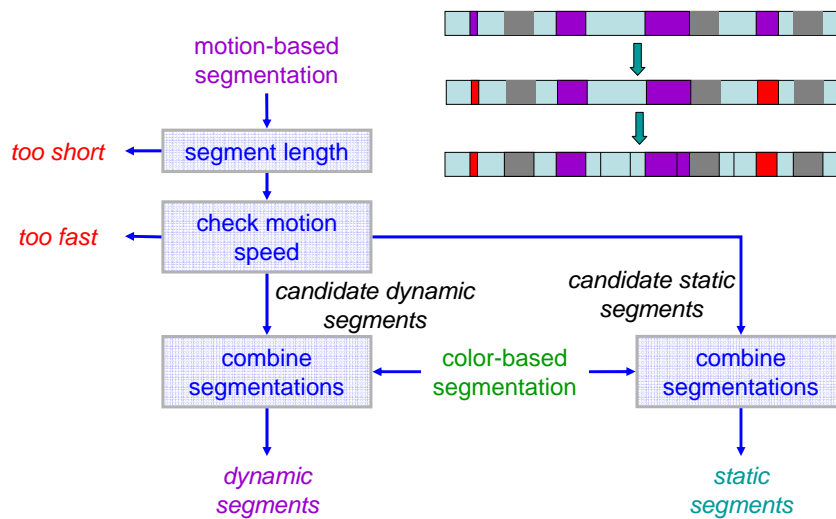


- Colorbars
 - few points found
 - little global motion
- Pans and zooms



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Segment Classification



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Finding Redundancies

- Cluster dynamic segments and static segments separately
 - similarity values have different ranges
 - can use different features and similarity measures
 - different weighting for each type of segment during segment selection

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Clustering Dynamic Segments

- Color, motion, temporal distance
- PLSA-based dimension reduction
 - color, motion
- Similarity matrix

$$S(i, j) = \exp\left(-\frac{(d_c(s_i, s_j))^2}{2\sigma_c^2} - \frac{(d_m(s_i, s_j))^2}{2\sigma_m^2} - \frac{(d_t(s_i, s_j))^2}{2\sigma_t^2}\right)$$

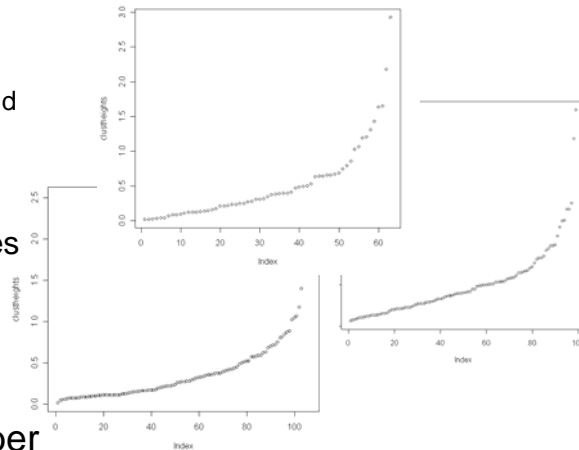
Odobez et al., 2003

- Spectral clustering
 - Adaptive threshold to determine number of clusters

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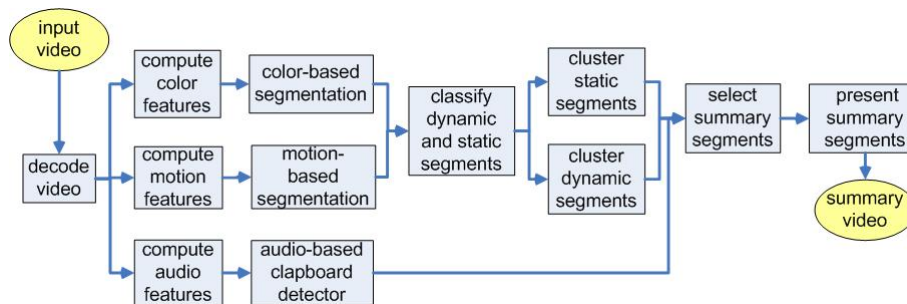
Clustering Static Segments

- Features
 - color only
 - temporal info did not make a significant difference
 - average block histogram values
- Agglomerative clustering
- Semi-adaptive threshold to determine number of clusters



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System Overview



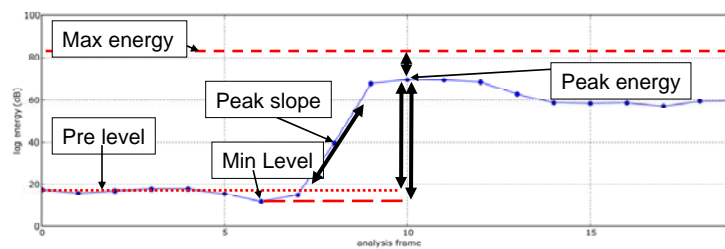
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Audio Clapboard Detection

- Loudness features to detect clapboard sounds



- Simpler than visual detector



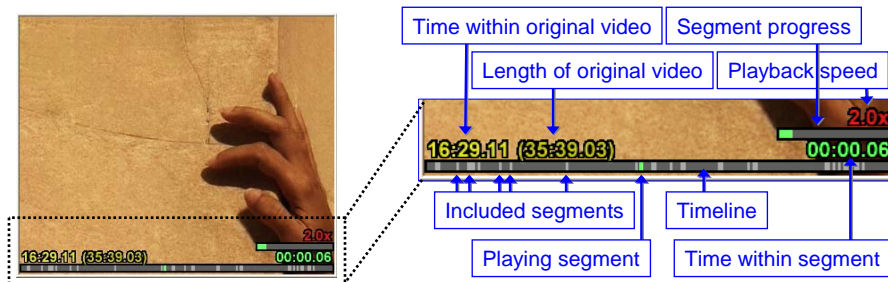
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Segment Selection

- Too few segments: default model
- Dynamic segments selected first
 - remove segments containing an audio clap
 - for each cluster, select segment representative of cluster and different than previously selected segments
 - max duration of 6 seconds
- Static segments selection
 - remove audio clapboards and singleton clusters
 - order clusters by total duration
 - for each cluster, select segment representative of cluster and different than previously selected segments
 - compute activity score of each segment
 - excerpt 3 second portion with highest activity score
- Stop when maximum summary duration reached or all segments included

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Summary Presentation



- Did not use picture-in-picture or tiled display
 - too small, busy
- Rapid playback
 - static scenes played at 1.5x
 - dynamic scenes played at a rate dependent on amount of activity
 - pitch-preserving rate transformation for more natural audio
- Add cues to indicate clip properties and context

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Outline

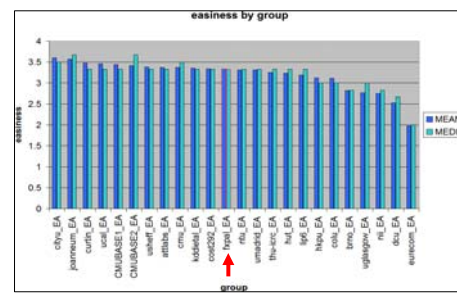
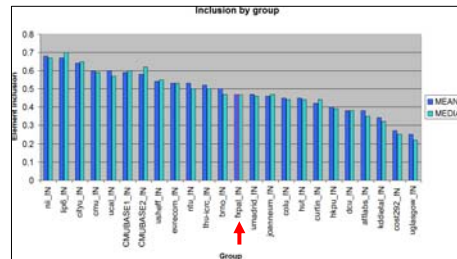
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Performance

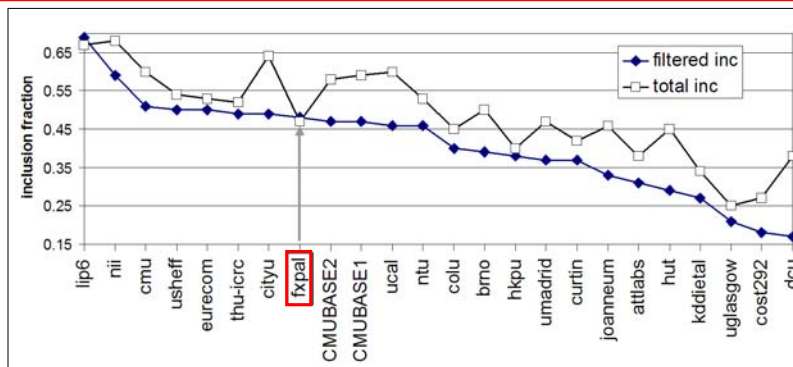


- Performance in middle by *inclusion* and *easiness* measures
- Fewer segments than baseline systems
 - longer segment durations
 - lenient filtering of non-interesting segments
- Default model too simple



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Camera Motion Performance



- Evaluate on subset of labeled inclusions
 - kept inclusions that mention “pan”, “zoom”, “tilt”
- Relative performance better
 - almost all other groups perform worse on this subset

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