VK Multimedia Information Systems

Mathias Lux, mlux@itec.uni-klu.ac.at

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Video Retrieval

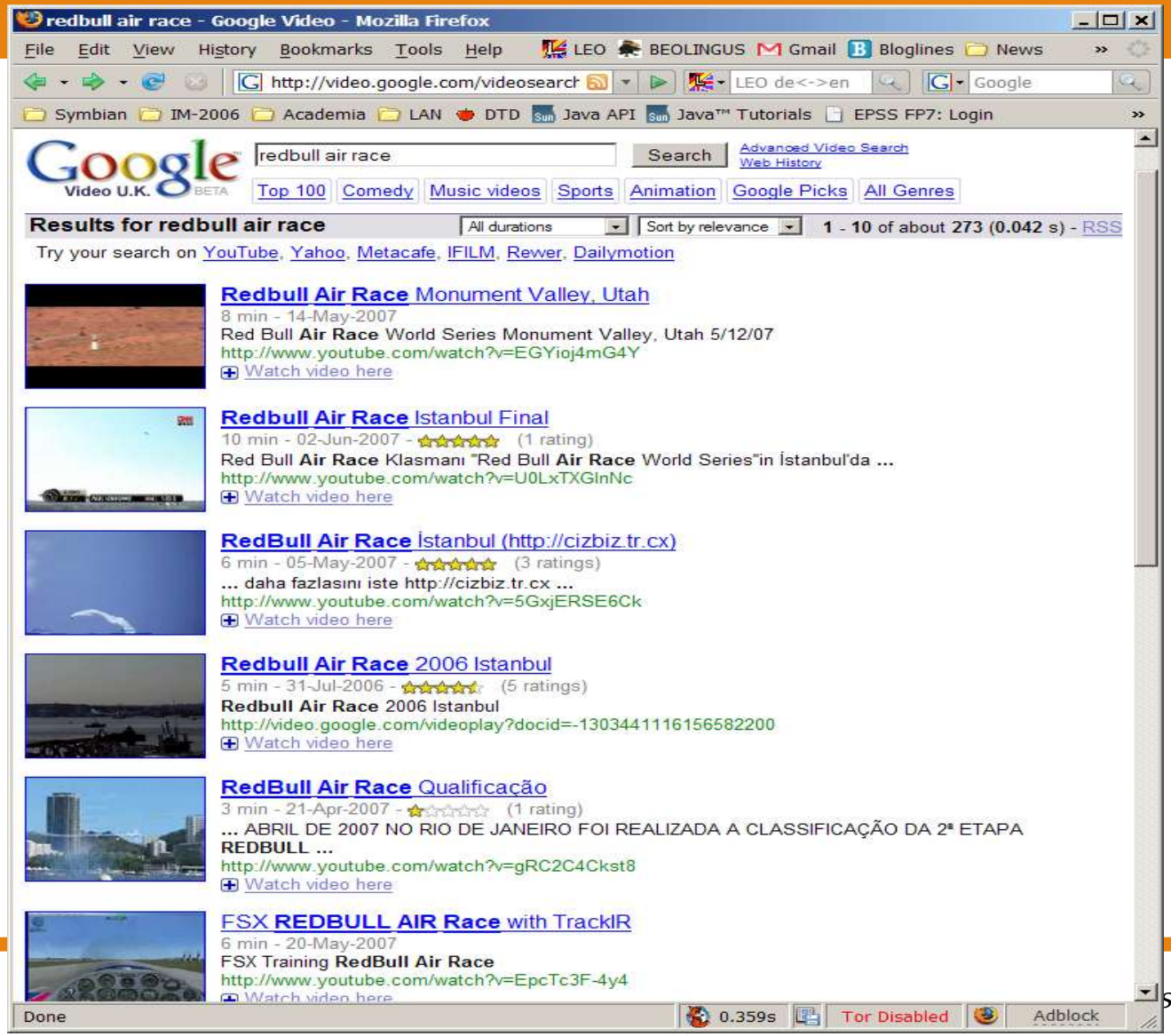
- Motivation & Problems
- Features & Descriptors
- Some Methods
  - Text Based
  - Shot Detection
- Video Retrieval Evaluation
- Applications
  - Video Summaries

Motivation

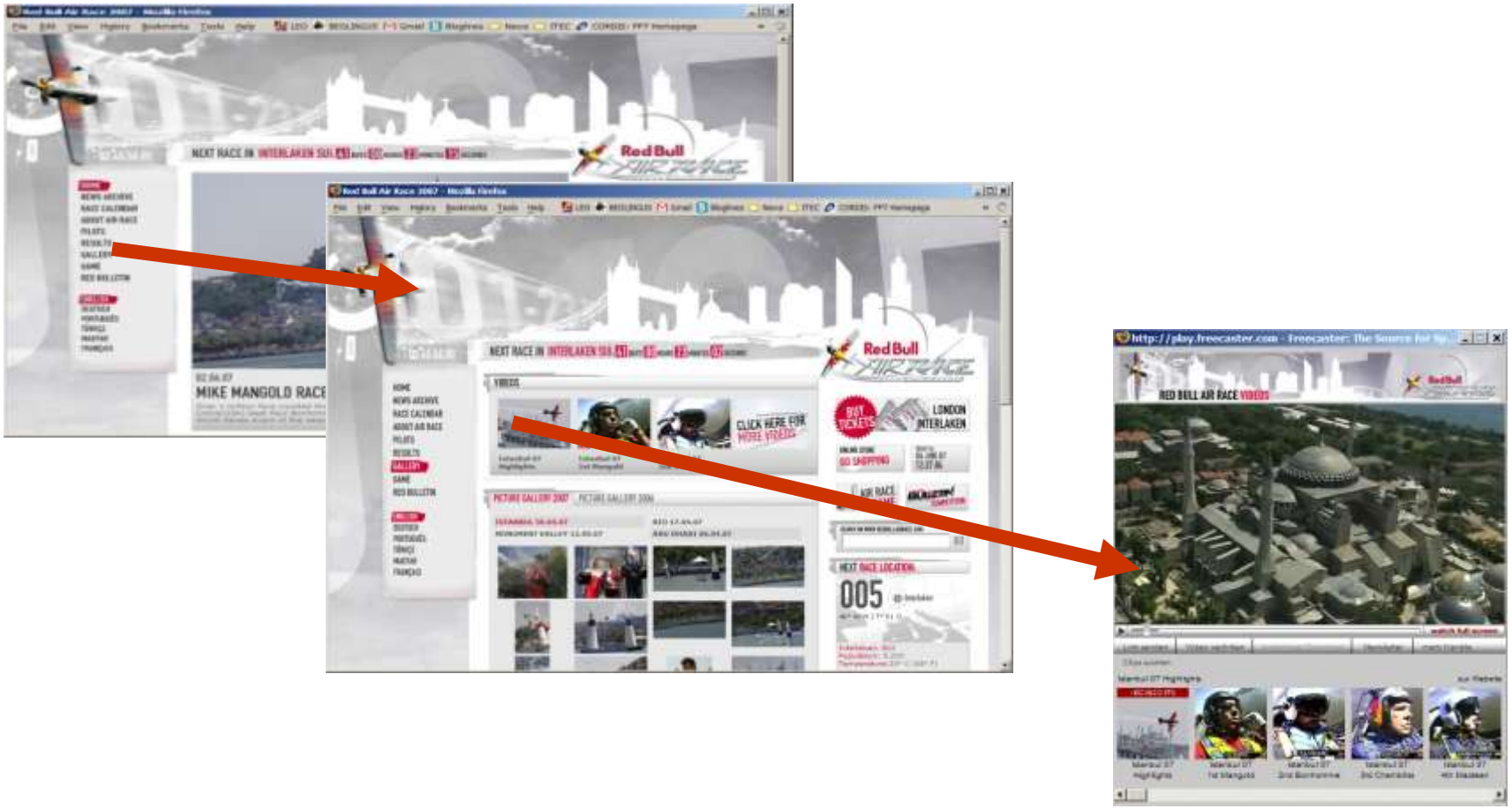
Szenario A: Ad Hoc Search - Pull Information

- Alice has heard about a recent event
  - Examples: Red Bull Air Race, etc.
- She wants to get an overview on
  1. Overview on **context**
  2. Coverage on the **outcomes & highlights**

Szenario A: Google Video



Szenario A: Web Site



Szenario A: Analysis

Google Video	***Air Race Web Site***
Simple (Term) Search	Navigation (Gallery -> Video)
Short and ambiguous descriptions	Clear and intuitive meta information (thumbnails)
No additional information / interlinking	Further information provided
Fast, clean and efficient interface	Frisky and colorful interface
Legal issues ...	No legal issues

Szenario B:

Szenario B: Media Obervation

- George B. wants to find everything
  - Concerning certain Persons / Communities
  - Capturing the mood of media
- This includes
  - News broadcasts (language independent)
  - YouTube, MyVideo, etc.

Problems

- Video Retrieval is a very broad field
  - Demands differ from professionals to hobbyists
- Videos are commonly rather ‘big’
  - Sighting of raw footage and search results is time consuming
  - Extraction, analysis and indexing of descriptors are challenging
- Indexing is rather complicated
  - Videos are multimodal

Example Problem: Size

- 15 minute video -> 25 fps, 720x576
  - # frames = 15 * 60 * 25 = 22,500
  - With 65k colors
    - Raw size = 22,500 * 720 * 576 * 2 ~ 17.4 GB
  - Indexed by color histogram
    - 256 colors with 256 levels each -> 16 Bit / frame
    - Size = 22.500 * 2 ~ 43.95 kB
  - In a video database
    - 1,000 videos -> ~ 44 MB descriptor data
    - 1,000,000 videos -> ~ 44 GB descriptor data

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Features and Descriptors

- Visual Descriptors:
  - Additional dimension: **Time**
  - Related to audio information
  - Movement (change over time)
- Audio Descriptors
  - Related to visual information
- Multiple Streams
  - Different languages, comments
  - Different angles / viewpoints

Video streams

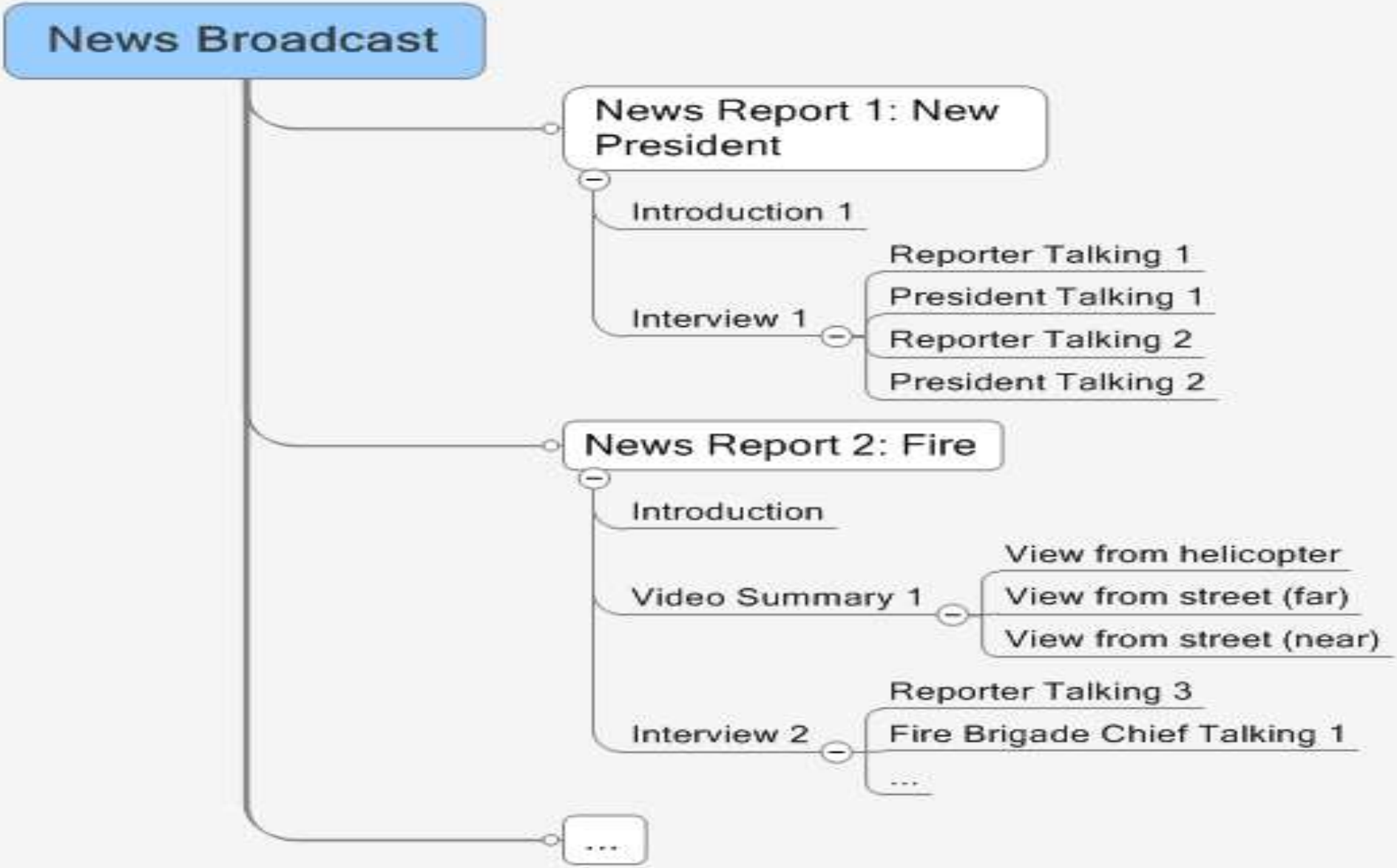
Video stream <-> sequence of still images

- Index single images
  - Using arbitrary features (color, texture, …)
- Instead of single picture
  - Group of Frames (short: GOF)
  - Group of Pictures (short: GOP)
  - e.g. averaged color of multiple frames

Video Streams

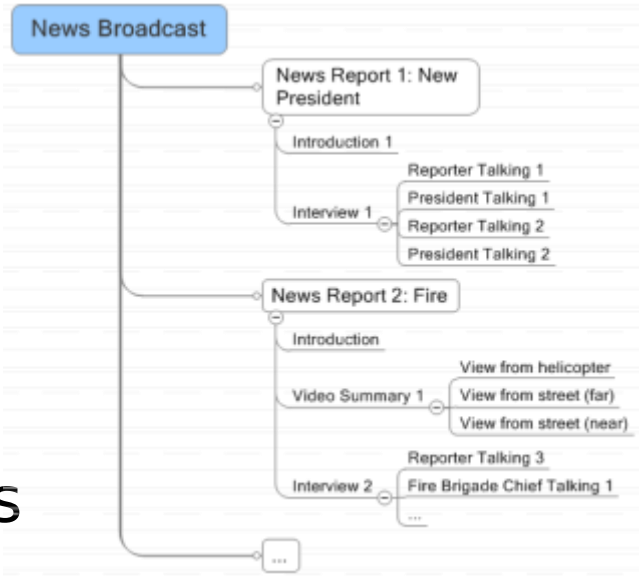
- Motion based descriptors
  - Find shots with zoom / pan
  - Camera vs. object motion
- Feature extraction
  - Motion estimation (see video coding)
  - Motion histograms
  - Dominant or averaged motion direction

Temporal Segmentation



Temporal Segmentation

- A single decomposition
  - Three different levels
  - Non-overlapping segments
- Visual and audio descriptors
  - Attached to nodes
  - Describing sequence of frames



Example: MPEG-7

- Multiple segmentation trees possible
- Different stream combined
- No “general description format”
  - How many segmentations / levels
  - Selection of descriptors at nodes
  - Interconnection of streams

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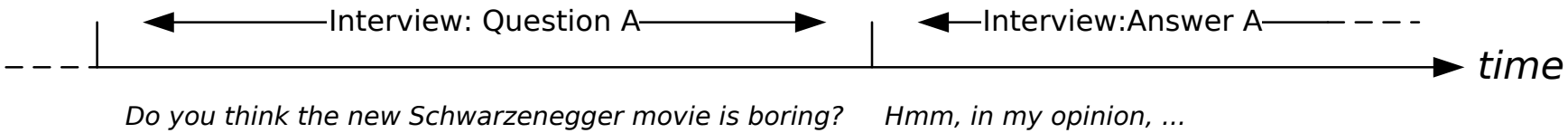
Text Based Retrieval

- Text annotations assigned to segments
  - Transcriptions, metadata, etc.
- Retrieval is based on text
  - Inverted lists
  - Retrieval of relevant parts/documents

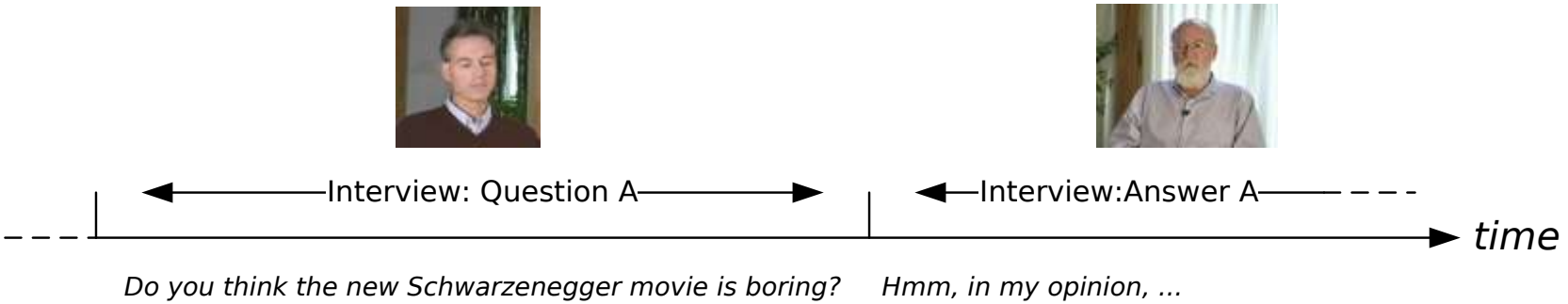


Text Based Retrieval: Applications

- Speech oriented videos
  - Speech recognition & manually
  - Transcription available for disabled people
  - Examples: News, Cartoons
- Metadata of videos
  - Tagging and descriptions like in YouTube
  - Manual annotations (e.g. sports videos)
  - Spotted keywords

Shot Detection

- Automatic Segmentation of video stream
  - Find frame where new shot starts
  - Find frame describing the shot best



Different Cuts

- Simple Cuts (elephantsdream)

- Transitions & combinations (casino royale)

Shot Detection: Methods

- Uncompressed Domain
  - Video is decoded
  - RGB or YUV values are used for computation
- Compressed Domain
  - Characteristics of the codec are exploited

Shot Detection: Uncompressed Domain

- Rather good methods already available
  - Detection up to 95%
  - Depends on domain
- General approaches
  - Low level features
  - Change over time, tracking rapid changes
  - Grey values / Color Histogram

Shot Detection: Uncompressed Domain

Common Algorithm

- For each frame n
  - Extract *histogram(n)*
  - Compute distance to *histogram(n-1)*: *d(n-1, n)*
  - If (*d(n-1, n)* > *threshold*) report shot boundary
- Problems
  - Each frame has to be decompressed
  - Threshold is domain dependent.

Shot Detection: Uncompressed Domain

- Scene heuristics
  - Studio environments (backgrounds)
    - Sports events
    - News broadcasts
    - Interviews, round tables and discussions
  - “Fade to black” transitions
    - Find black frames as shot boundaries
  - Boundary scenes
    - e.g. “Millionenshow”, ads, …
    - Common duration, average color

Shot Detection: Compressed Domain

- Motion Vectors
  - Investigate major direction / amount changes
- Bit Rate
  - VBR: Higher amount -> shot boundary
- Number Macro Blocks / Type
  - More I-Blocks -> shot boundary
- Position of I-Frames
  - Actually a shot detection in encoding

Video Indexing based on Shots

- Indexing Shots instead of frames
  - Number of shots depends on the domain
  - Considerably smaller than number of frames
- What to index about a shot?
  - Identify one or more “key frames”
  - Index the key frames
- Retrieval based on shots
  - Result is “part of the video”
  - Grouping possible, weighting neccessary

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Retrieval Evaluation

- Similar to IR Evaluation
- Several different tasks
  - Depending on the forum

Retrieval Evaluation Forums

- TRECVID
  - Indexing and searching in video DBs
- VideoCLEF
  - Video content in multilingual environments
- INEX Multimedia
  - XML (Fragments) based multimedia retrieval

TRECVID 2007

- Shot boundary Detection
  - Automatic comparison to human annotation reference data.
- High Level Feature Extraction
  - Classification based on 39 concepts
- Search
  - Ranked list based on shots compared to test collection
  - automatic, manually assisted & interactive
- Rushes Summarization
  - Management of raw video material (near duplicate scenes, no audio etc.)
  - Evaluation by a single human judge

VideoCLEF 2008

- Classification Task: Vid2RSS
  - Dutch television footage
  - Dual language: English & Dutch
  - Both contribute, not translations
  - Transcriptions, keyframes, metadata provided
  - Task: RSS feed for each category
- ImageCLEF
  - Image retrieval tasks

INEX Multimedia

- Retrieving relevant document fragments with multimedia character
- Input (Query):
  - Either Text or Text & Image
- Output (Result):
  - Image or text or both
- Evaluation
  - Human assessment

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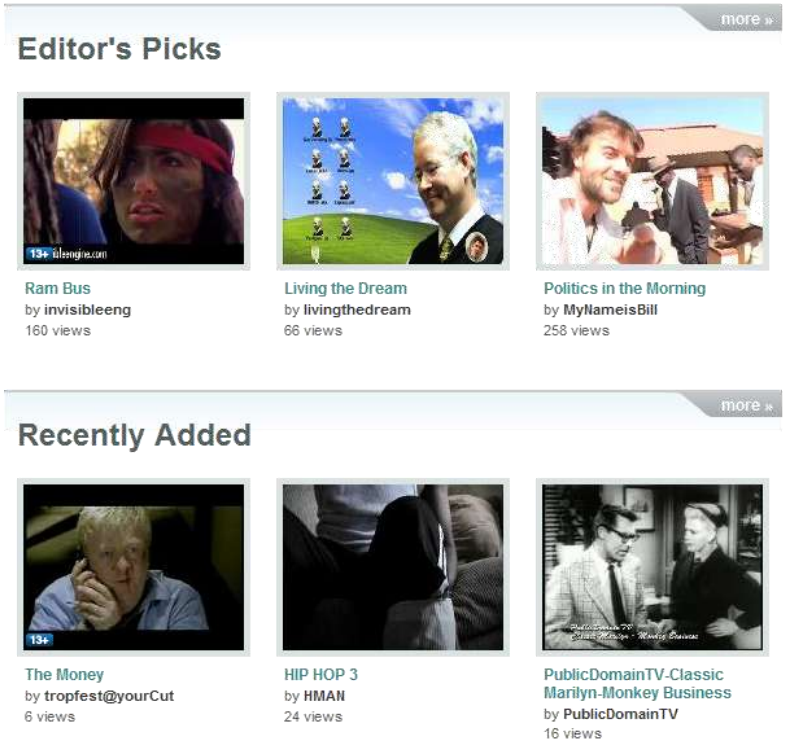
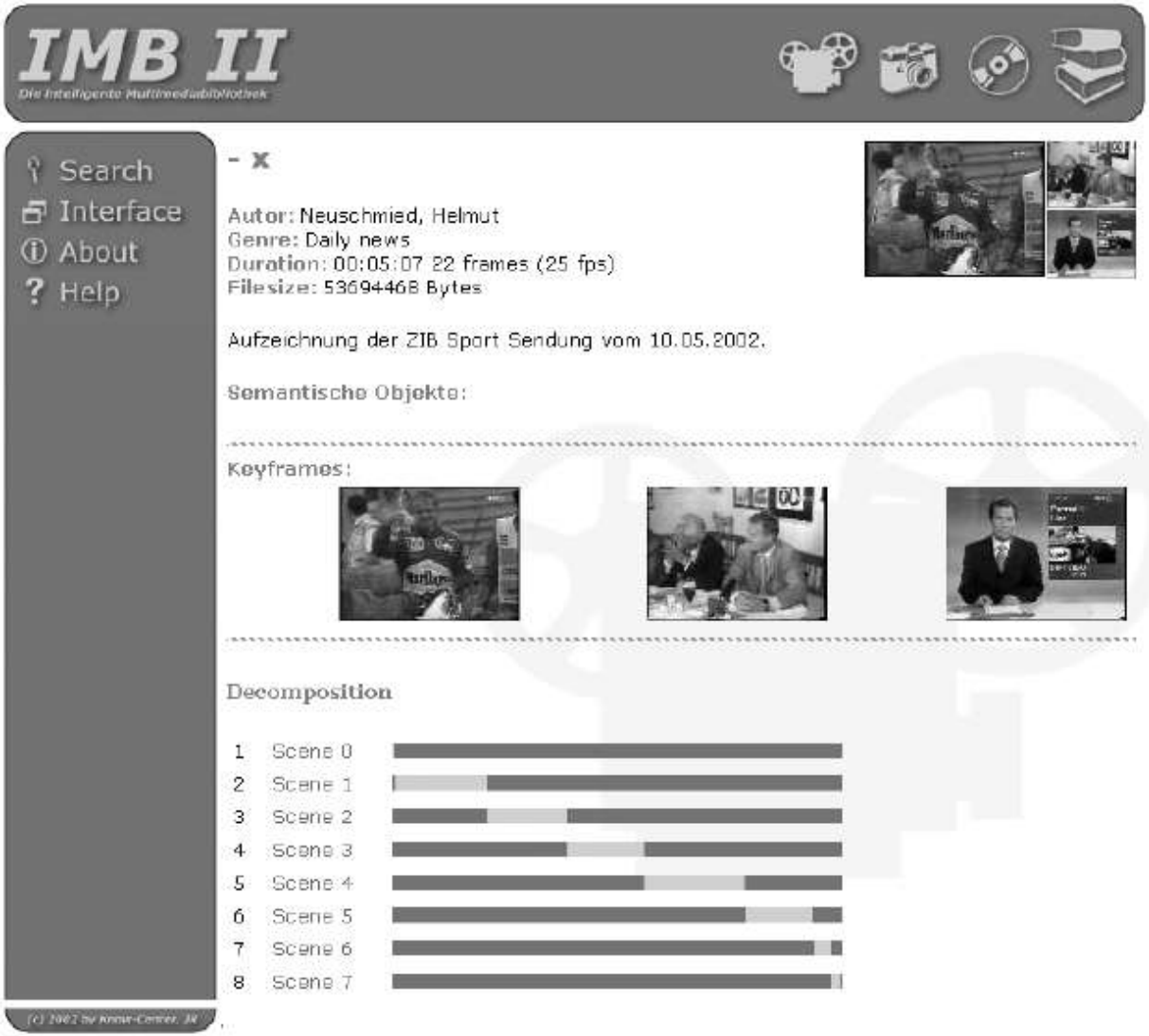
Video Summaries

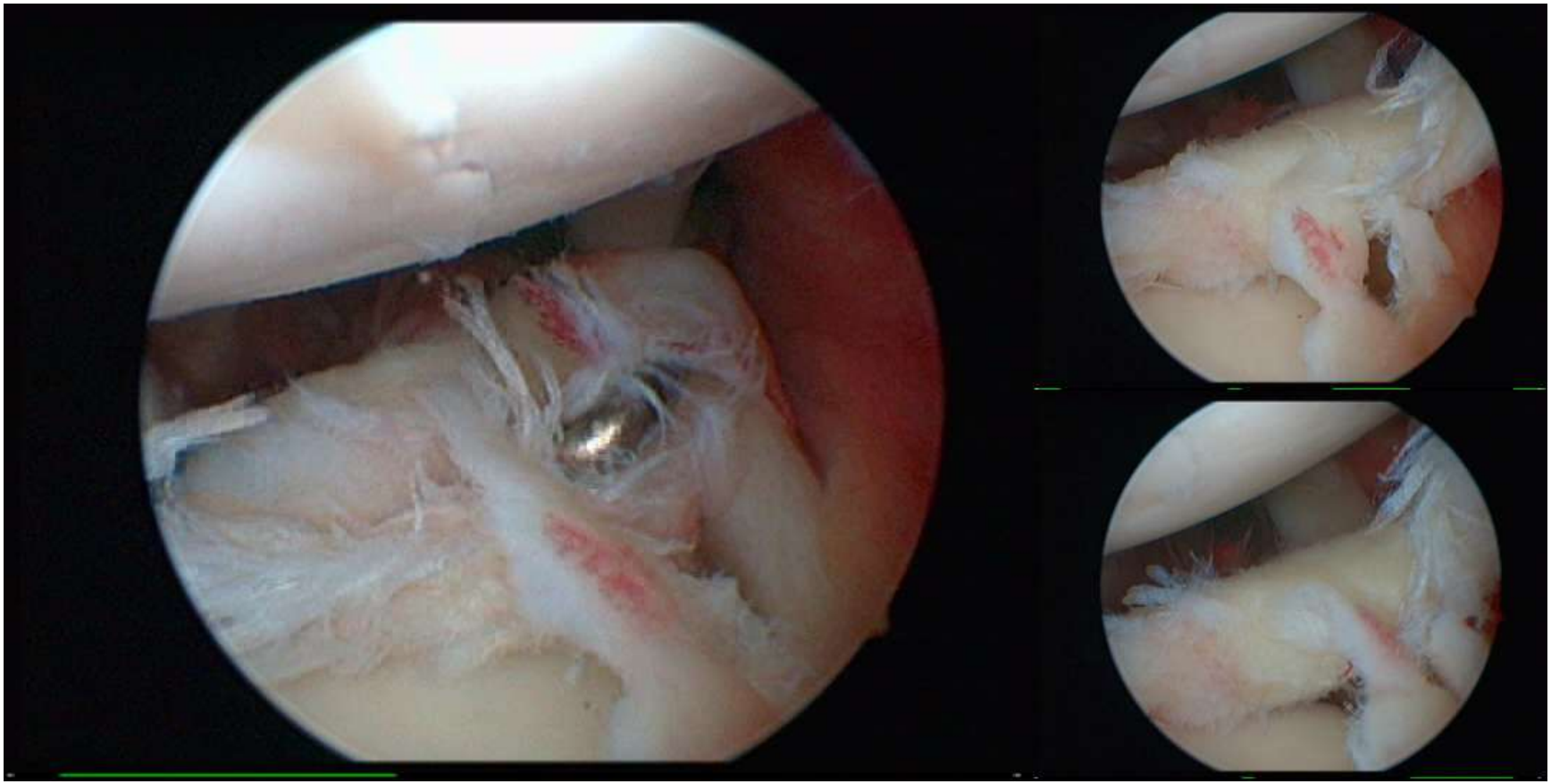
- Methods for getting the most out of a video in minimum time



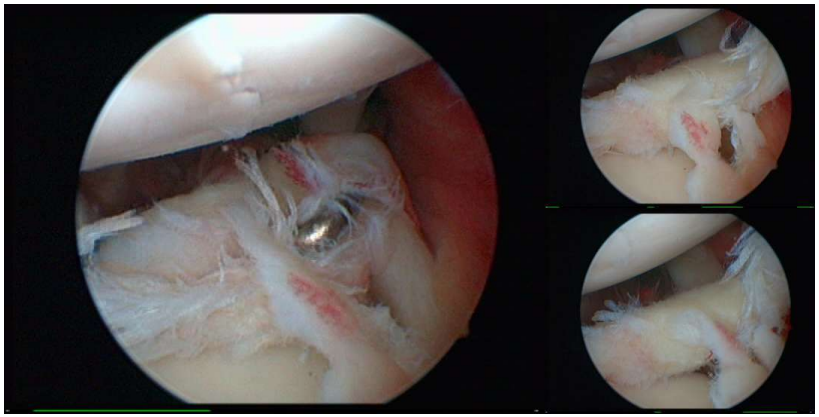
Video Summary Example

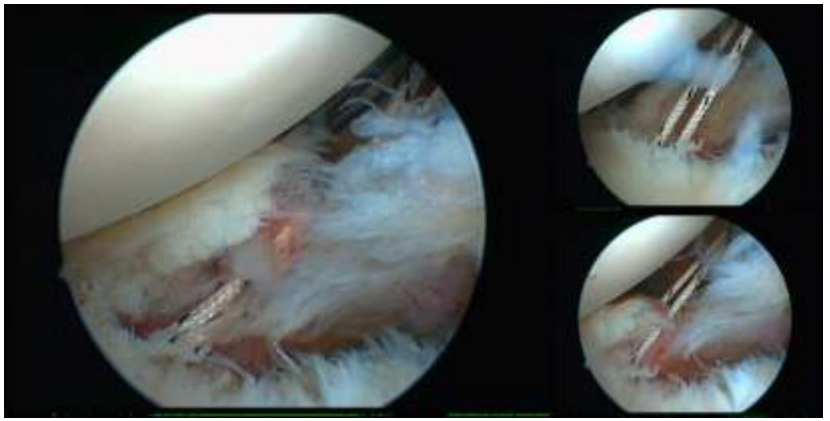


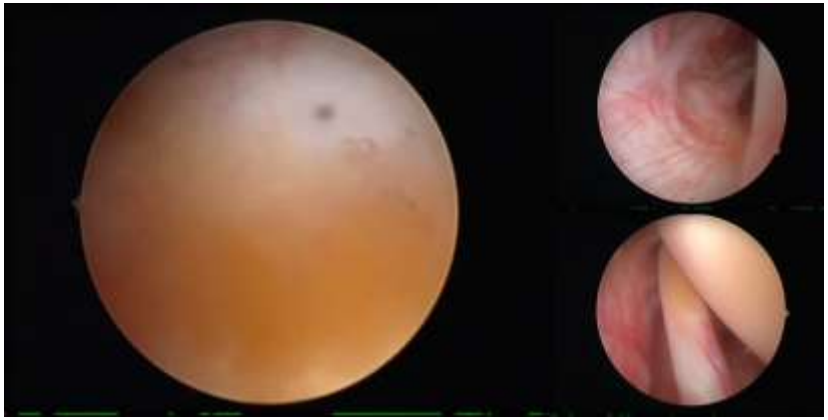
Medical Videos

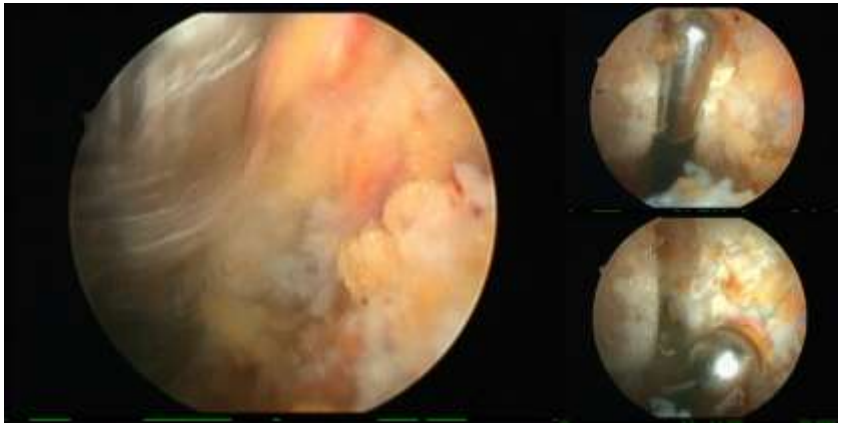


Medical Videos









Video Summaries

- Video Skims
  - Short sequences
  - Cut from the video
  - Like a trailer
  - Eventually with audio
- Key frames
  - Selection of still images

Video Summaries: Key Frames

Goals

- Select appropriate frames for a summary
- Weight frames according to relevance
- Visualize in an ‘optimal’ way

Problems

- Which are the most relevant frames?
  - Sort out transitions, motion blurred frames
- How many are there?

Video Summaries: Key Frames

- Selection of key frames
  - Either visualized at once or
  - Rotated in a loop

http://www.myvideo.de/watch/1544203

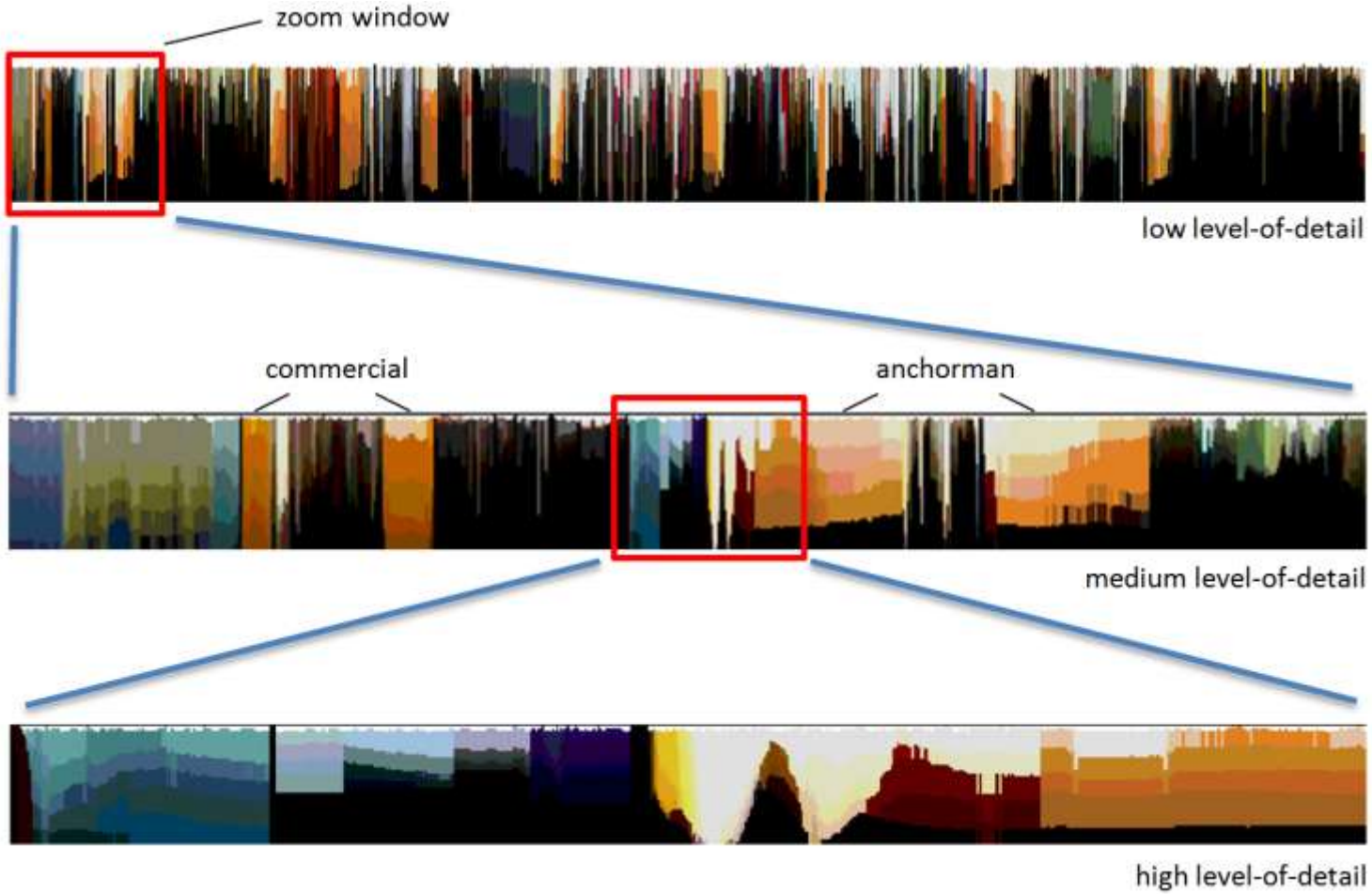
Video Summaries: Stripe Images

- Only one pixel column per frame
- Concatenate the pixel columns
  - frame height = stripe image heigth
  - frame number is stripe image width
- Visualization Benefits
  - Size of shots, Movement
- Visualization Disadvantages
  - No ‘big picture’

Video Summaries: Stripe Images

src. PhD Klaus Schöffmann

Video Summaries: Dominant Color



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Dominant Color vs. Stripe Images

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Sliding Storyboard

Figure 8.7: Sliding Storyboard at lowest level-of-detail.

Figure 8.8: Sliding Storyboard at medium level-of-detail.

Figure 8.9: Sliding Storyboard at higher detail.

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Motion Histograms

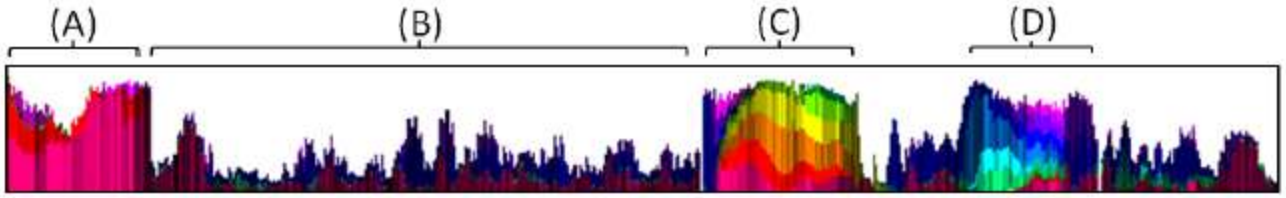

Figure 8.4: Motion visualization ($K = 12$) for 25 seconds of a news video. The letters denote scenes as follows: (A) fast approaching car from the right, (B) an interview (with small amount of slow motion), (C) fast zoom originating from right above, (D) fast zoom originating from bottom left. Adapted from [SLTB09, STB09]

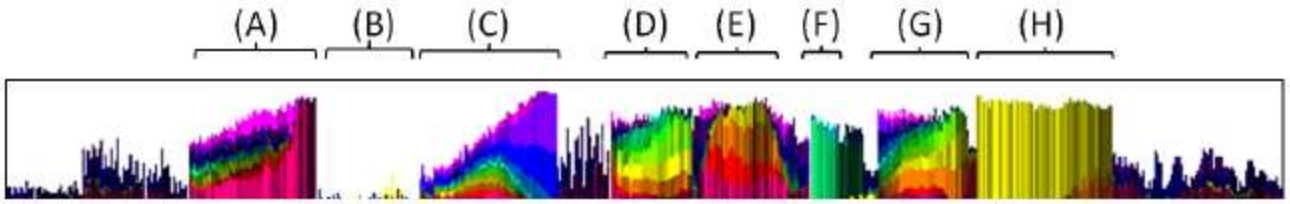

Figure 8.5: Motion visualization ($K = 12$) for 24 seconds of a news video. The letters denote scenes as follows. (A) zoom-in from bottom right, (B) still scene, (C) zoom-in, (D) zoom-out, (E) zoom-out, (F) pan-right (background moves left), (G) zoom-out, (H) pan-down (background moves up)

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Key Frames Video Summary Generation

- Approaches use most salient frames
  - Based on user attention models
    - Motion, static shots, faces, etc.
  - Clustering & SVD
    - Employ dimensionality reduction
    - Find groups and take representative group members
    - The bigger the group the more important
  - Optimization
    - Minimizes sum of distances to all other frames.
    - While maximizing the distances between key frames

Exercise

- Create a video summary
  - e.g. of the “Uncharted 2 Trailer”
  - http://www.youtube.com/watch?v=69EBDlnDw2k
- Use e.g. Javascript to grab video
  - http://googlesystem.blogspot.com/2008/04/download-youtube-videos-as-mp4-files.html
- Decide yourself which visualization you want to implement ...
  - Do not use frames displaying text
- Send me the resulting image / document

Exercise Option: Stripe Image

- Use **FFMPEG** to grab frames
  - e.g. the windows binary
  - `ffmpeg -i [invideo] -f image2 -ss frame%6d.png`
  - see e.g. http://wiki.cs.sfu.ca/vml/DigitalVideoHowTo
- Use e.g. **Irfanview** to put them together
  - Batch Processing -> Crop images ...
  - Image -> Panorama image ...

Thank you ...

... for your attention