A Simple and Easily Parallelized Video Copy Detection Method

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Video Copy Detection

- Useful alternative to watermarking
- A problem with many possible solutions
  - TrecVid helps in evaluation, but is not enough
  - Need some more evaluation criteria
- Our goals: Small amount of index info per frame, search efficiently, effectively and have search process easy to parallelize

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Alternative Approaches

- Global methods
  - Descriptor from global image characteristics
  - Compact, but difficult to make effective
- Local methods
  - Find local feature points (like SIFT)
  - Effective, but difficult to make compact

Combine local and global

- Find all the SURF feature points in a frame
- Divide image into 4 by 4 regions
- Count feature points in each of these regions
- Descriptor for each frame is the count of the number of feature points (less than 256)
- Have a 16 byte descriptor for a video frame

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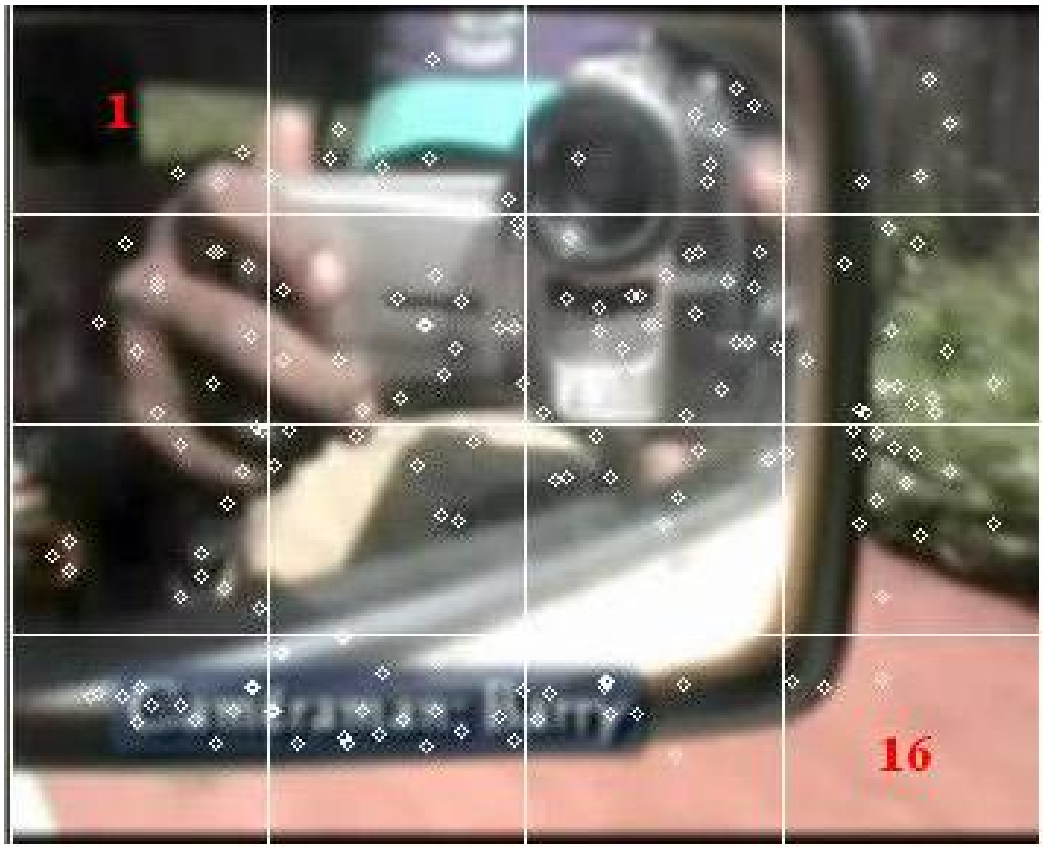
Descriptor is (1,6, …, 3)

- Tested 2x2, 4x4, and 8x8 descriptors



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What about other descriptors?

- Historically, ordinal measures are good global descriptors (invariant)
- First tried PACT, a recent ordinal descriptor

32	64	96		1	1	0
32	**64**	96	$\Rightarrow$	1	0	$\Rightarrow (11010110)_2 \Rightarrow \mathrm{CT} = 214$
32	32	96		1	1	0

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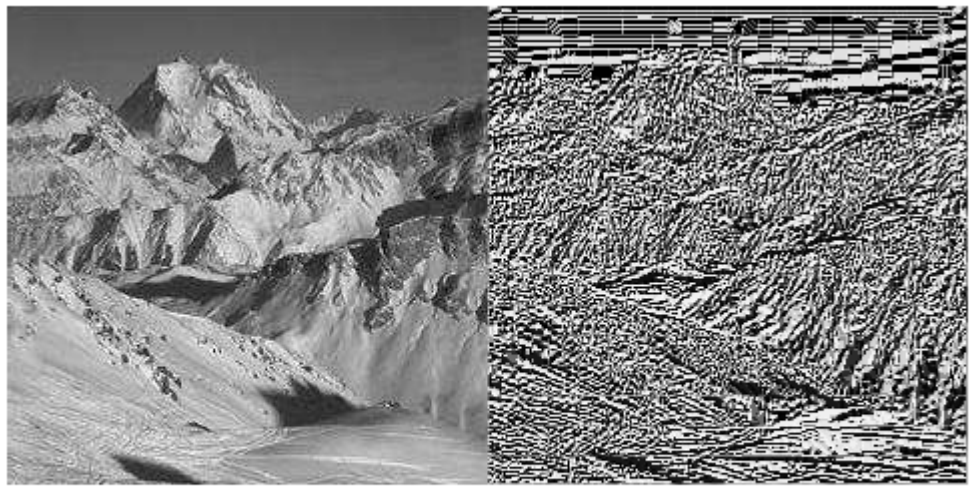
PACT Ordinal Descriptor

- Transform byte => byte for entire image
- Descriptor not compact nor effective?

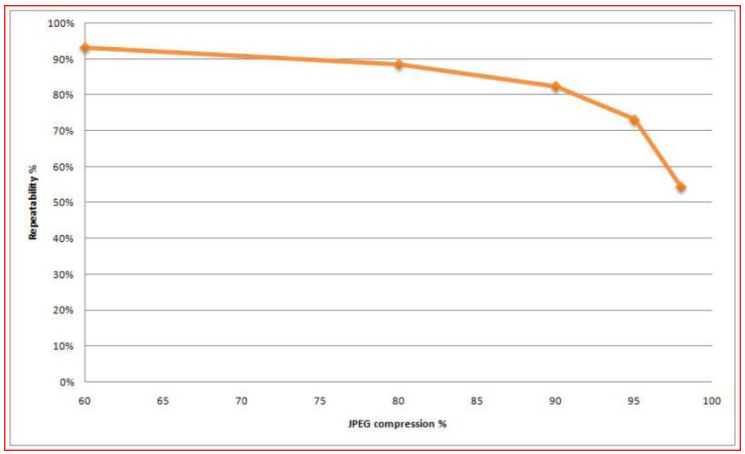


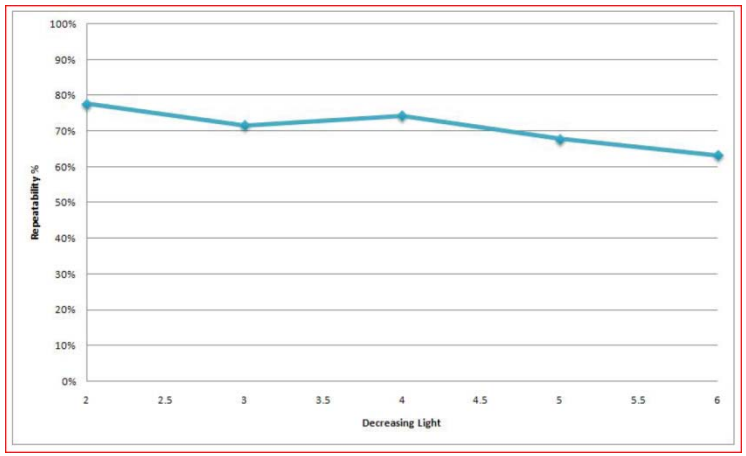
(a) mountain image (b) Transformed image

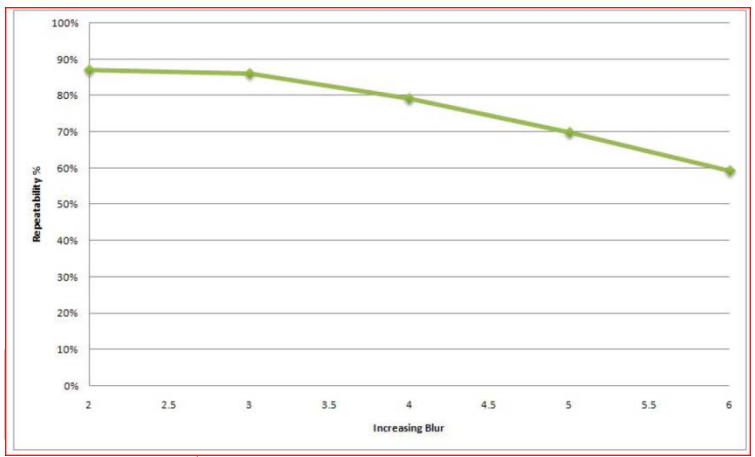
SURF Feature Points

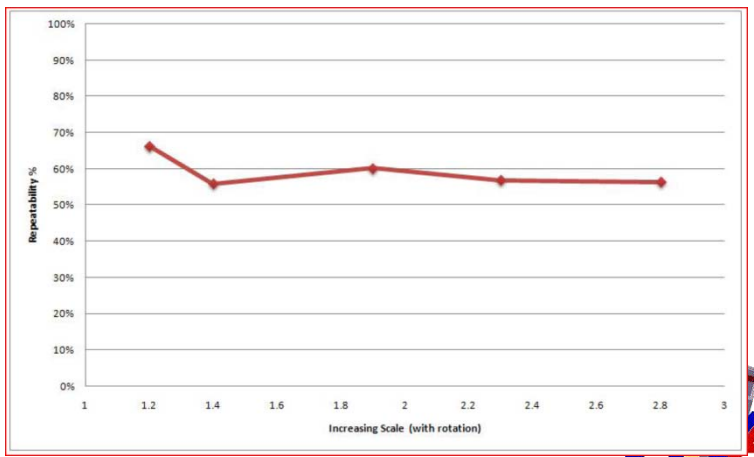
- Finds features (interest points) in an image

SURF Characteristics









Advantages of our descriptor

- Feature counts are very compact
  - 90,000 frames in an hour of video requires only 1,440,000 bytes (1.44 mbytes)
- Is effective
  - Use natural invariance of the SURF features
  - In video we compare a sequence of descriptors so we do not need a more powerful descriptor

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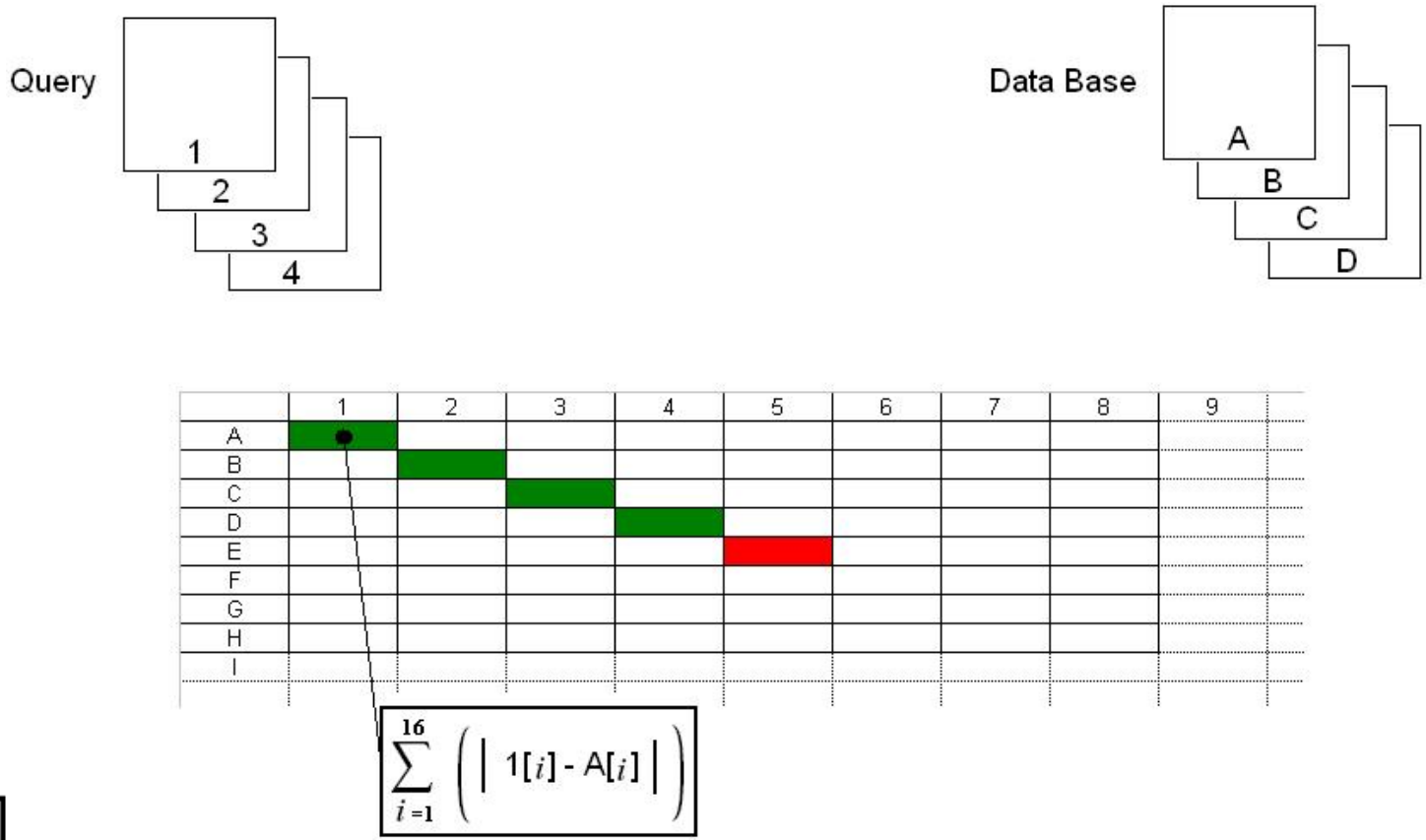
Comparing descriptors



Skipping bad matches

	A	B	C	D
1	S<thresh			
2		S<thresh		
3			S<thresh	
4				S>thresh

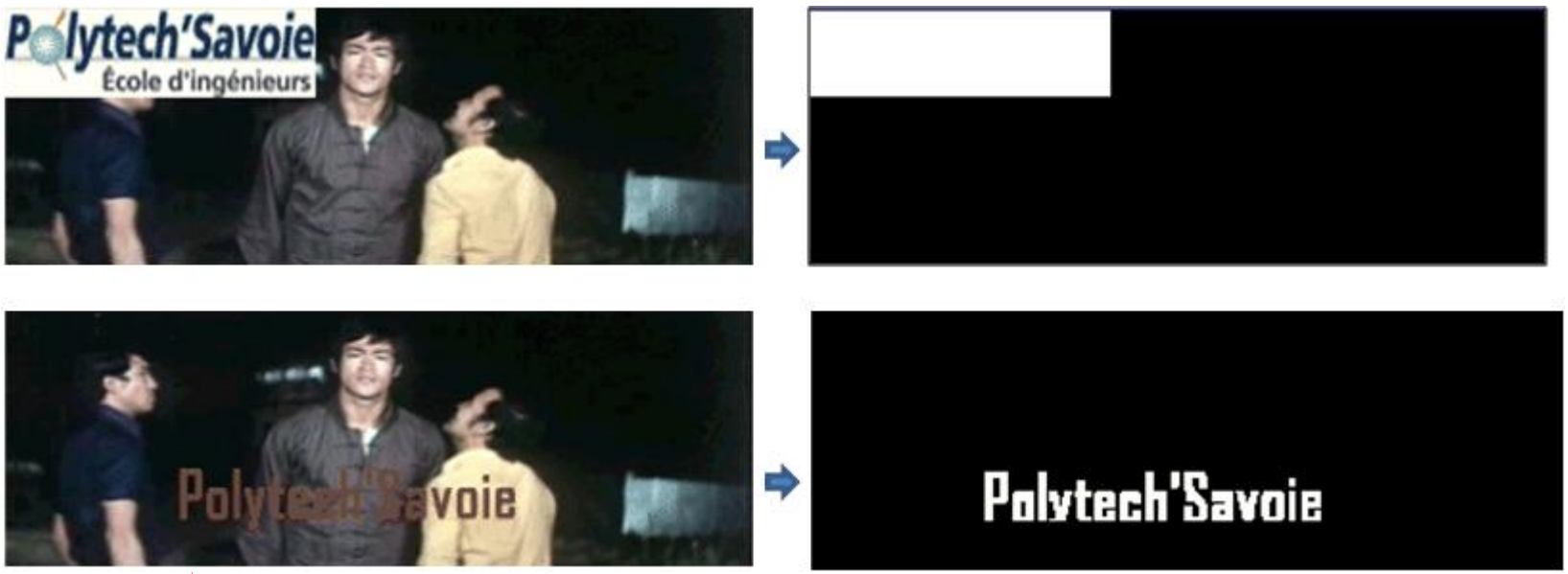
Creating masks

$$\sigma^2 = \sum_{i=1}^{n} \frac{(x_i - \mu)^2}{n}$$

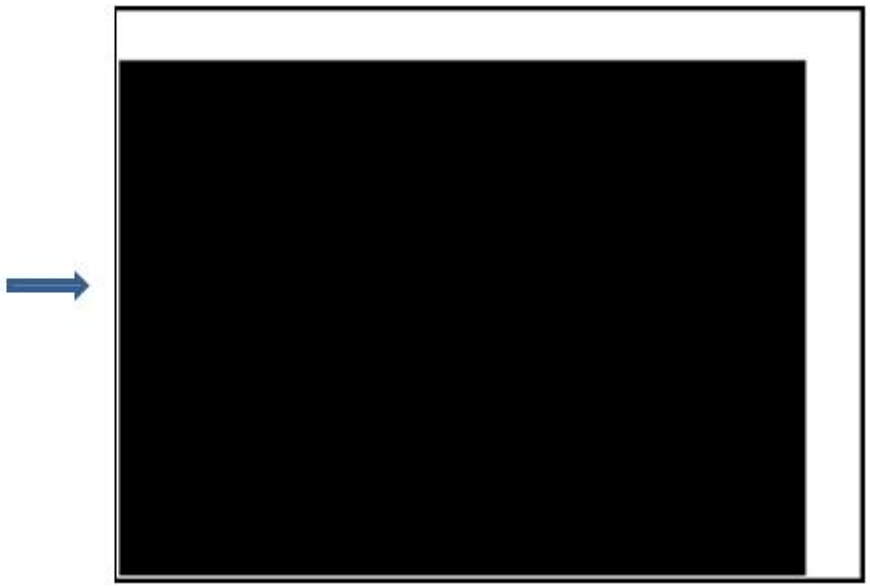
When σ = 0 draw the pixels as white

Otherwise draw the pixels as black

Text Insertion Mask



Shift Mask



Mirror Transform

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

→

4	3	2	1
8	7	6	5
12	11	10	9
16	15	14	13

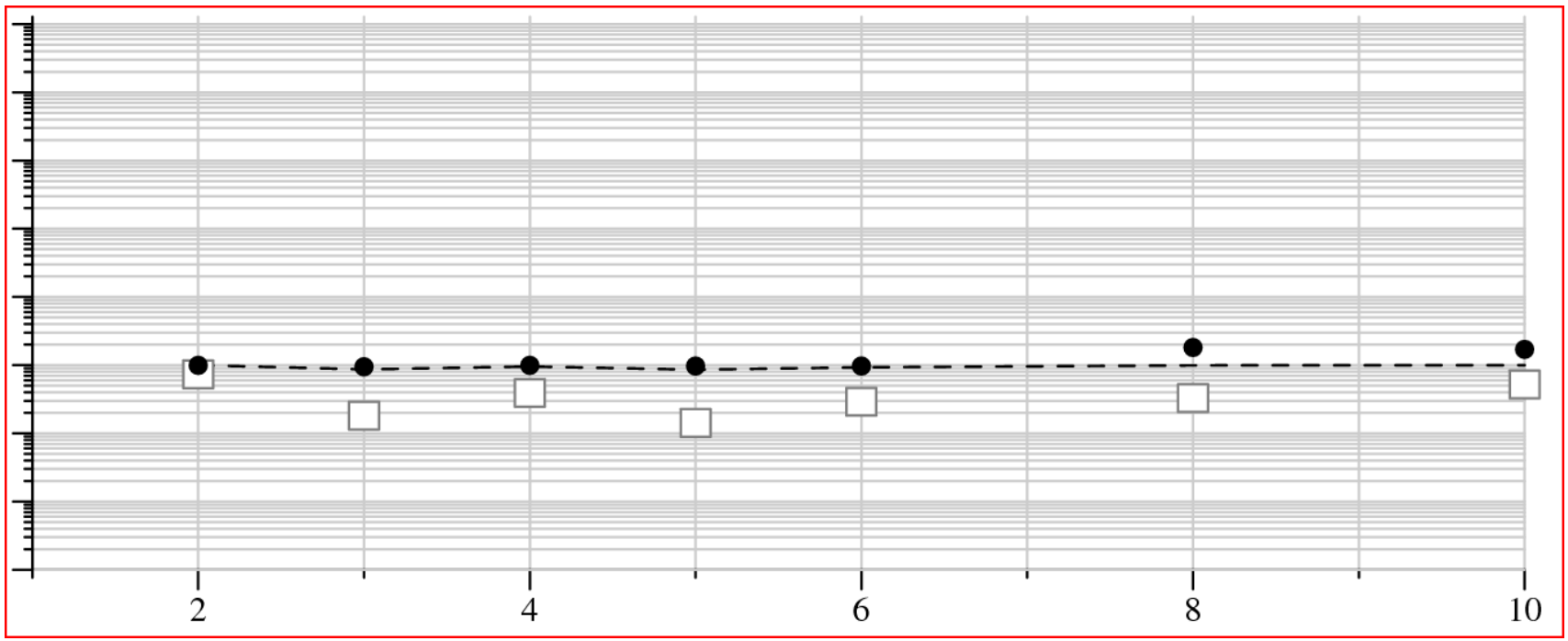
Audio Matching

- Based on coherence function using intermediate features in ITU-R BS.1387 Perceptual Evaluation of Audio Quality
- Idea of using PEAQ features was to include psychoanalytic effects such as critical bands, frequency masking and loudness

Performance

- Video only – NDCR around the median, while the F1 (localization) is near the top
- Audio only – slightly worse than median NDCR, low false pos., but high false neg.
- Combined – audio only boots the video, not very good results (not clear why?)

Video NDCR – Balanced Insert



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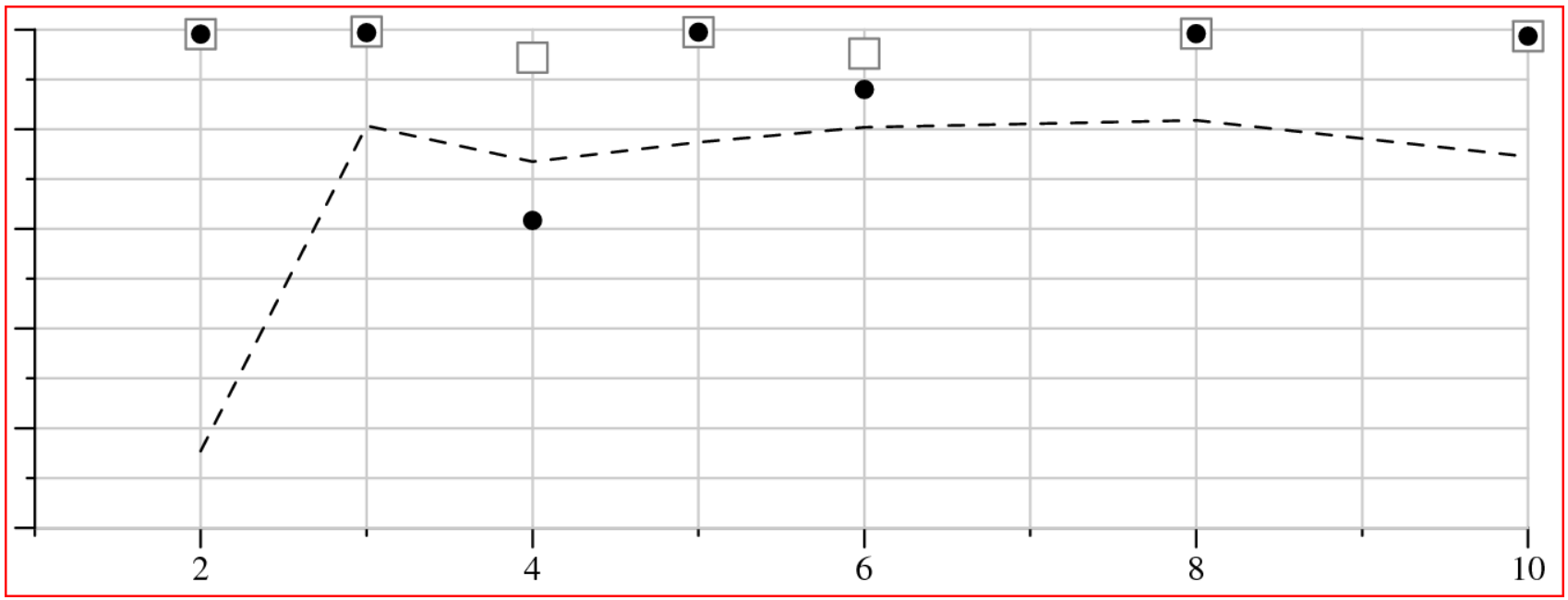
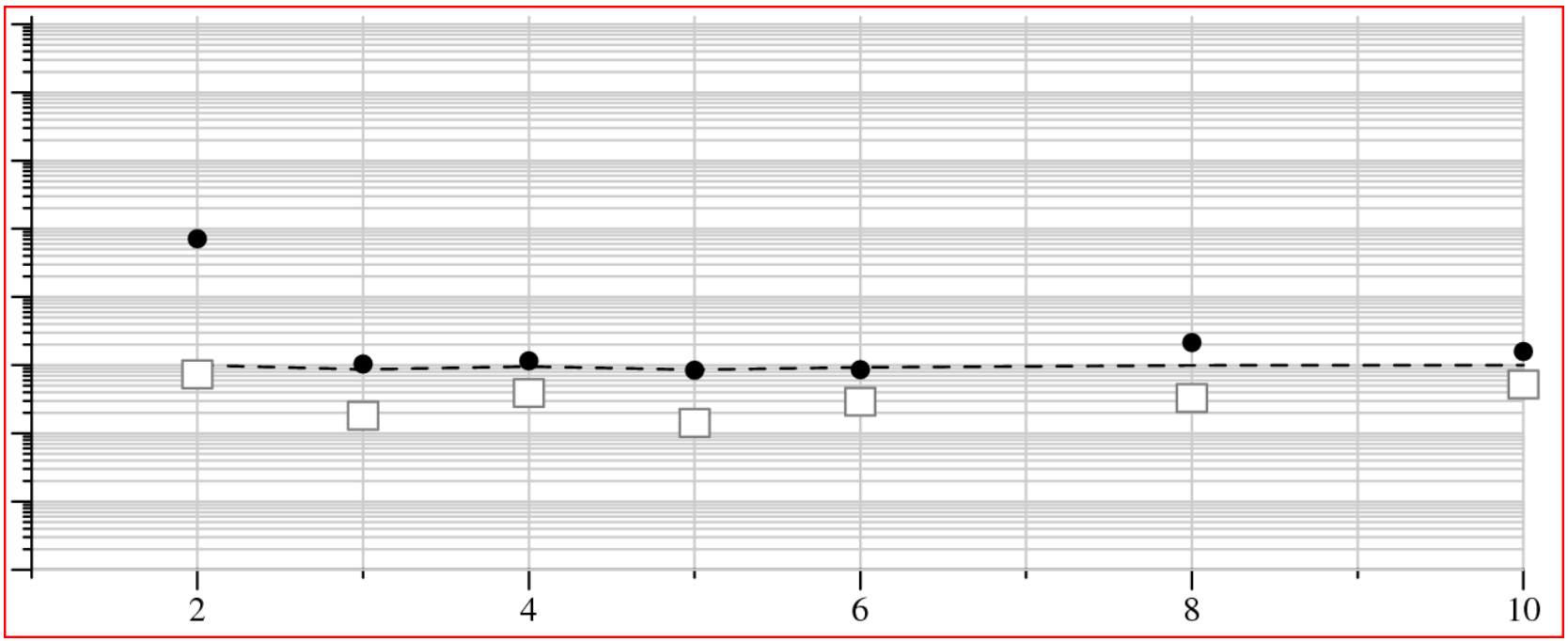
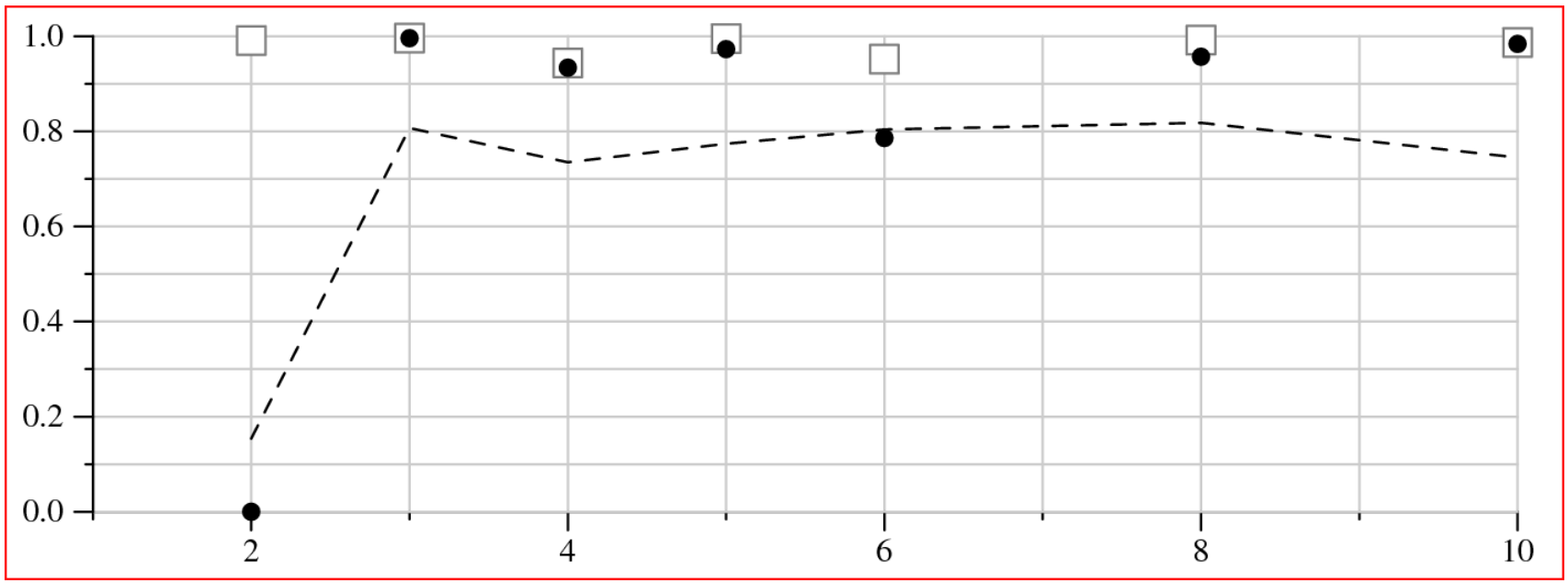
Video F1 – Balanced Insert



Video NDCR – Balanced No Insert



Video F1 – Balanced No Insert



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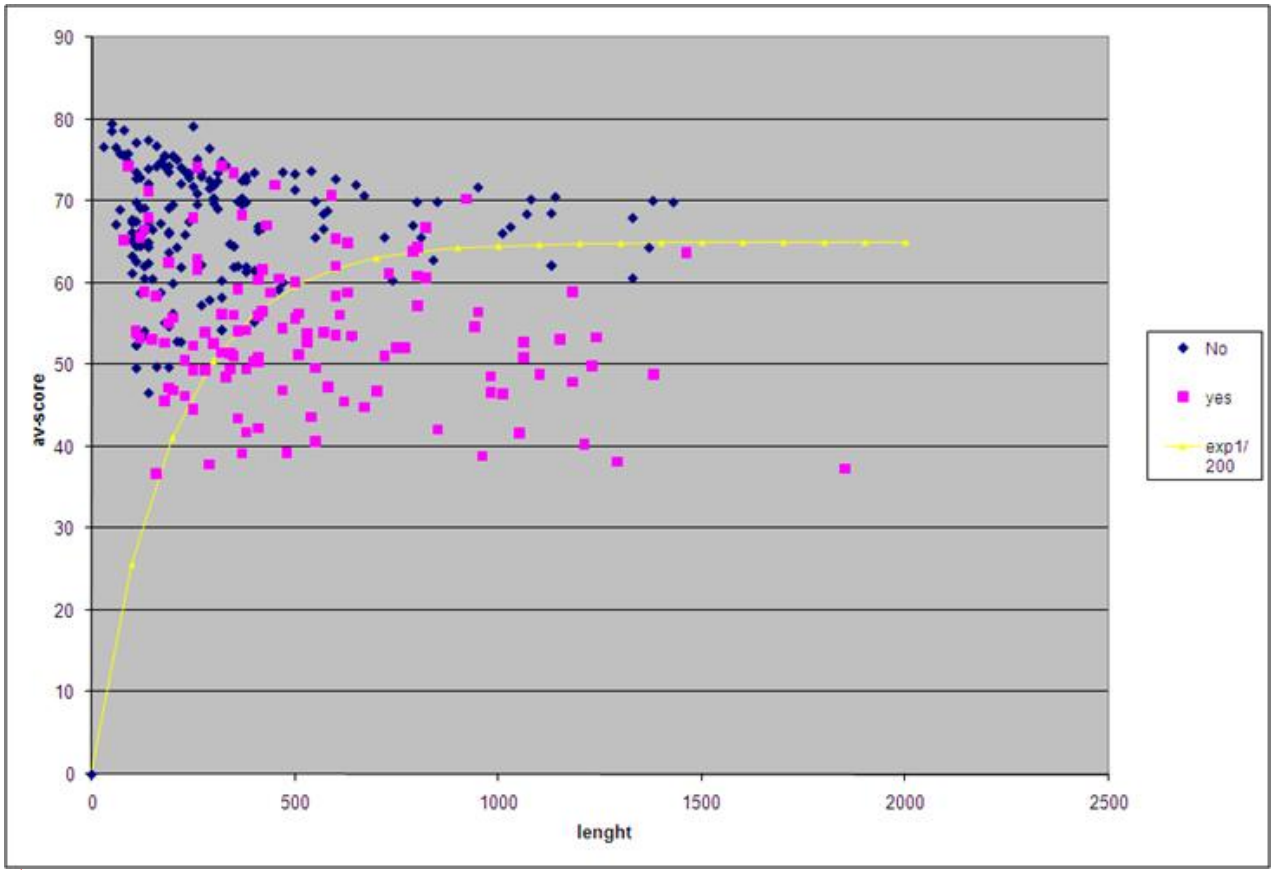
Improved Thresholding



Parallel Processing

- Algorithms must run on parallel hardware
- What is ease of parallelization?
  - Best if no reprocessing is necessary for a different assignment of dbase files to processor
  - If you have intermediate data structures (like tree or hash table, then this not the case)
  - Our method allows trivial parallelization

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Future Work

- Implement parallelization on GPUs
- Better combination of audio and video
- Better decision thresholding (as described)
- Different feature points with this approach
  - Use real-time feature extraction (like Harris) for on-line commercial removal (simple transform)
  - Detect many commercials in real-time

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