Probabilistic Image Retrieval

Introduction

Analysis of a video as a single entity by modeling one-second video sequence around the keyframe

Gaussian Mixture Model in DCT-space-time domain

Extension of the Static Probabilistic Retrieval model

Thijs Westerveld, Arjen P. de Vries: Experimental result analysis for a generative probabilistic image retrieval model. SIGIR2003: 135-142

Pursue video retrieval instead of keyframe retrieval

Static Retrieval Model

Given query image \( x \) consisting of \( N \) samples

\(( x = x_1, x_2, ..., x_N )\), collection image (document) \( w \) is compared to \( x \) by computing its ability \( \text{(RSV)} \) to explain the samples \( x \):

\[
\text{RSV}(w) = \frac{1}{N} \sum_{j=1}^{N} \log \{ k P(x_j | w) + (1-k) P(x_j) \}
\]

Documents

- Document models
- Query

Probabilistic Image Retrieval

Example

Query:

What is the probability that the pieces of this query are drawn from each of the documents models?

Model [Vasconcelos 2000]

Gaussian Mixture Model (GMM)

Each sample from an image is generated by 1 of \( C \) components

\[
P(x | w) = \sum_{c=1}^{C} P(C_c) G(x | \mu_c, \Sigma_c)
\]

\[
G(x | \mu, \Sigma) = \frac{1}{\sqrt{(2\pi)^n |\Sigma|}} \exp \left( -\frac{1}{2} (x - \mu)^T \Sigma^{-1} (x - \mu) \right)
\]

Conclusions/Future Work

Conclusions

- appropriate keyframe less critical
- can model (dis)appearance of objects
- modeling sequence around the keyframe better than taking not connected frames from the full shot
- combining textual and dynamic visual models better than ASR only
- best results with multiple examples round-robin merged, topical filters and non-visual modalities

Future Work

- more data needs more computation effort – optimizations ?
- integration of audio
- modeling of motion and texture over time

Building Dynamic GMMs

The Dynamic GMM captures the disappearing of the grass in the video sequence. The corresponding component (green dynamic space-time blob) dissapears at about \( t=0.4 \)

This effect is impossible to be captured from the static model where time is not taking into account

Gaussian Mixture Model (GMM)

Dynamic GMM

Extension of the Static Probabilistic Retrieval model

Gaussian Mixture Model in DCT-space-time domain

One-second video sequence around the keyframe

Like sorting the pieces of a jigsaw

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Compute means for each class

Assign pieces to random component

Take samples

Compute means for each class

Apply algorithm

Re-assign pieces

Dynamic GMMs

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