Human Action Recognition Using Semi-Latent Topic Models

Yang Wang and Greg Mori , 2009

SE367 Paper Presentation

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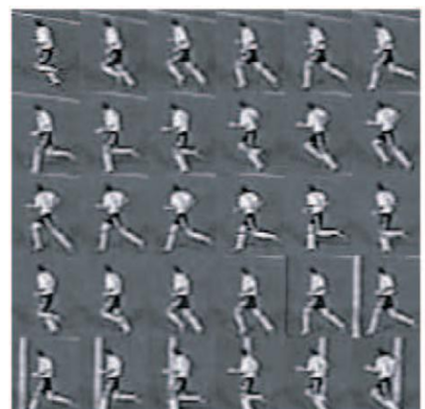
Introduction

- Human Action Recognition (**What** ?)
- Still Images (eg: Poselets)
  v/s
  Video Sequences
- Motivation:
  Bag of words representation of image – good results in Object Recognition



1	1	1	1	1	10
20	32	32	32	1	1
18	21	21	21	28	32
32	32	11	10	10	10
10	20	33	32	32	1

Bag of Words

[Wang,Mori,2009]

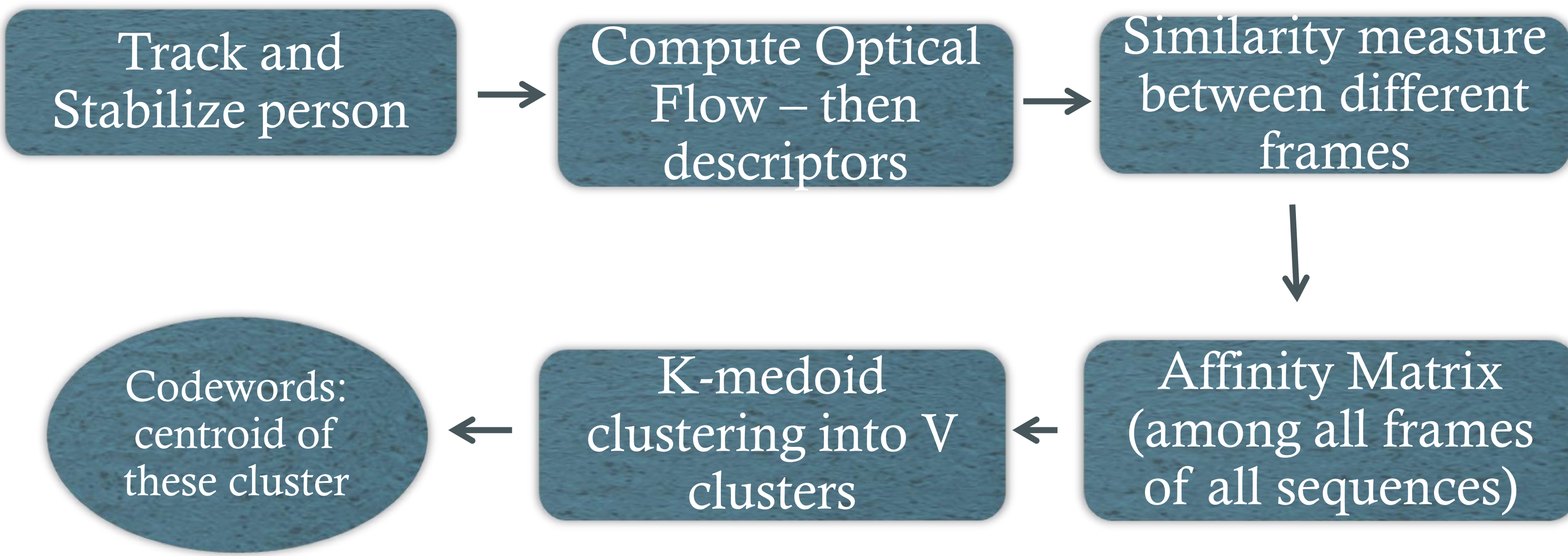
Earlier Work (Action Recognition)

- Motion Based:
  Learning features which based on visual cues (motion + shape) , optical flows
- Temporal Dynamic Models:
  Generative (e.g. HMM) and Discriminative (e.g. CRF) to model and learn features
- Interest Point Methods:
  Capture local features e.g. train SVM over the features obtained by STIP
- Topic Models:
  “Bag of Words” Paradigm.
  (analogous to NLP)

Bag of Words
(analogue: NLP to VISION)

Word	⟷	CodeWord (Each frame)
Vocabulary	⟷	CodeBook (all codewords)
Topic	⟷	Action Label
Document	⟷	Video Sequence

Construction of CodeBook



* Here codeword capture large scale features (containing overall temporal information of all videos in training set)
* Each video is a sequence of frames where each frame is represented by any codeword obtained above, thus video is a bag of words, removing temporal information.

Topic Models

- LDA : Genereative model to learn the distribution of topics(actions) given a document(video) and distribution of topics (action) over words (codewords).
  - Dirichlet Distribution
- CTM : Similar but Logistic Distribution to properly correlation of different topics in a document.

Proposed Modification →

- Semilatent LDA: Introduces supervision in LDA by making use of action labels present in training dataset.
  - Thus, better estimate the parameters of probability distribution
- Semilatent CTM- Supervised CTM

  Note: Don't have to choose topics as they are just equal to class labels (unlike unsupervised)

Classification

- Classify each frame in the sequence:
  For each frame, given frame calculate its distribution over action labels i.e. $p(z_i \mid \boldsymbol{W})$.
  Here, we chose **W** instead of just the corresponding frame so as to ensure that action label not just depend on the frame itself but video sequence as a whole

- **SLDA** : Models/approximates this probability distribution using other distribution by minimizing KL divergence between the two.

- **SCTM** : It approximates by using coordinate ascent techniques (Variational EM-expected maximization)

- Firstly **we can classify each frame** using distribution over action labels(take maximum) and then if video contains single action then perform majority voting.

Results

(per video classification)

- KTH Dataset:
  SLDA - 91.2%
  SCTM - 90.33%

- Weizmann Dataset:
  SLDA - 100%
  SCTM - 100%

- Hockey Dataset:
  SLDA - 87.5%
  SCTM - 76.04%

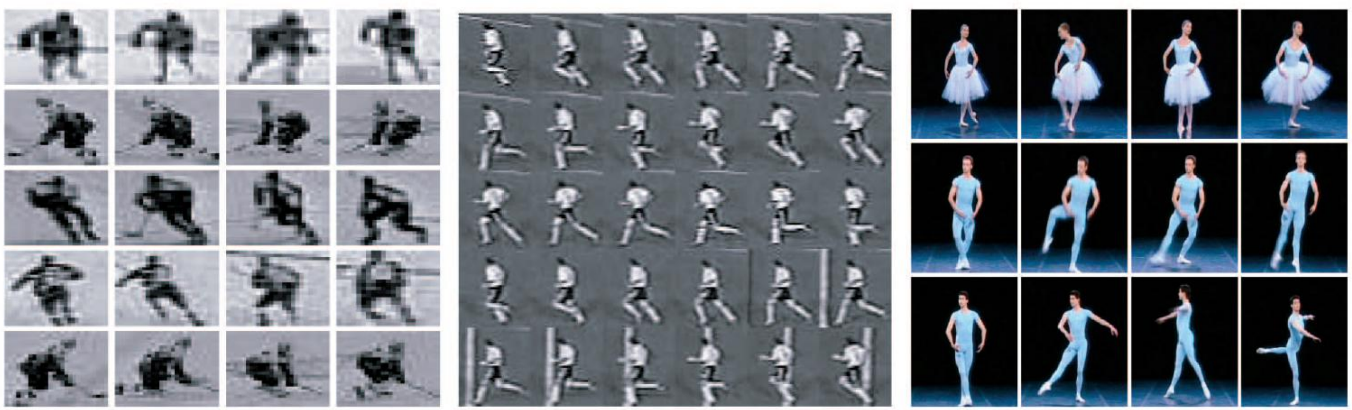
- Soccer Dataset:
  SCTM - 78.64%
  SLDA - 77.81%

- Ballet Dataset:
  SCTM - 91.36%
  SLDA - 88.66%

  CTM captures correlations better than LDA, thus performs better on multiple action video datasets (i.e. soccer & ballet).

Datasets

(a) (b)



[Wang,Mori,2009]

<u>Sample frames from our datasets</u>

Conclusion

- **Proposals**:

1. A novel "Bag of words" approach for representing video sequences where each frame corresponds to a word, thus capturing large scale features.

2. Two new models : SLDA & SCTM which are basically supervised form of LDA &CTM, thus training is easy with better performance.

- **Benefit**: This paper focuses mainly on per-frame classification, thus works significantly well on datasets of video containing multiple actions.

References

- Wang, Yang, and Greg Mori. "Human action recognition by semilatent topic models." *Pattern Analysis and Machine Intelligence, IEEE Transactions on*31.10 (2009): 1762-1774.
- Blei, David M., Andrew Y. Ng, and Michael I. Jordan. "Latent dirichlet allocation." *the Journal of machine Learning research* 3 (2003): 993-1022.
- Lucas, Bruce D., and Takeo Kanade. "An iterative image registration technique with an application to stereo vision." *Proceedings of the 7th international joint conference on Artificial intelligence*. 1981.

Thank You

Questions ?