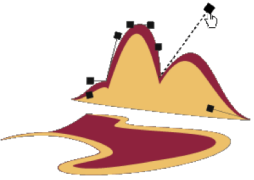


# Nude Detection in Video using Bag-of-Visual-Features

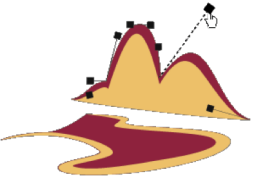


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Anderson N. A. Peixoto (UFMG), Rodrigo S. Oliveira (UFMG),  
Marcelo de M. Coelho (EPCAR/UFMG), Arnaldo de A. Araújo (UFMG)



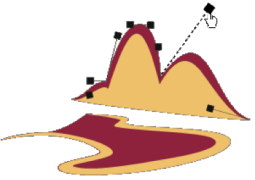
# Introduction (1/2)

- There is a vast amount of multimedia data nowadays
- Filtering improper multimedia material by its visual content is needed



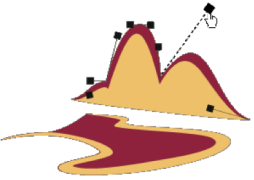
# Introduction (2/2)

- Skin detectors
  - Precise skin detection is not a trivial task
  - Generic geometrical model X Various body poses
- BoVF representation...
  - ...has great success in object recognition tasks and...
  - ...is robust to several variations and occlusion



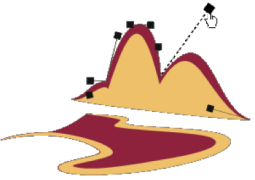
# Goals

- A method for detection nudity in videos
  - Bag-of-Visual-Features
  - Voting scheme



# Related Work

- Color, texture and geometric constraints
- Gaussian Mixtures Models
- Expectation-Maximization
- Support Vectors Machines (linear and non-linear)
- Different color models (YIQ, YUV, and HSV)
- **Bag-of-Visual-Features (First time!)**



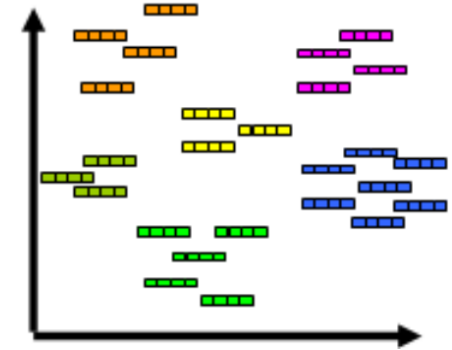
# Representing Images as BoVF



1) Point selection



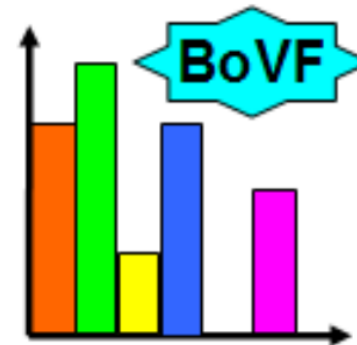
2) Point description



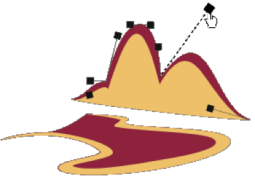
3) Vocabulary discovery



4) Cluster association

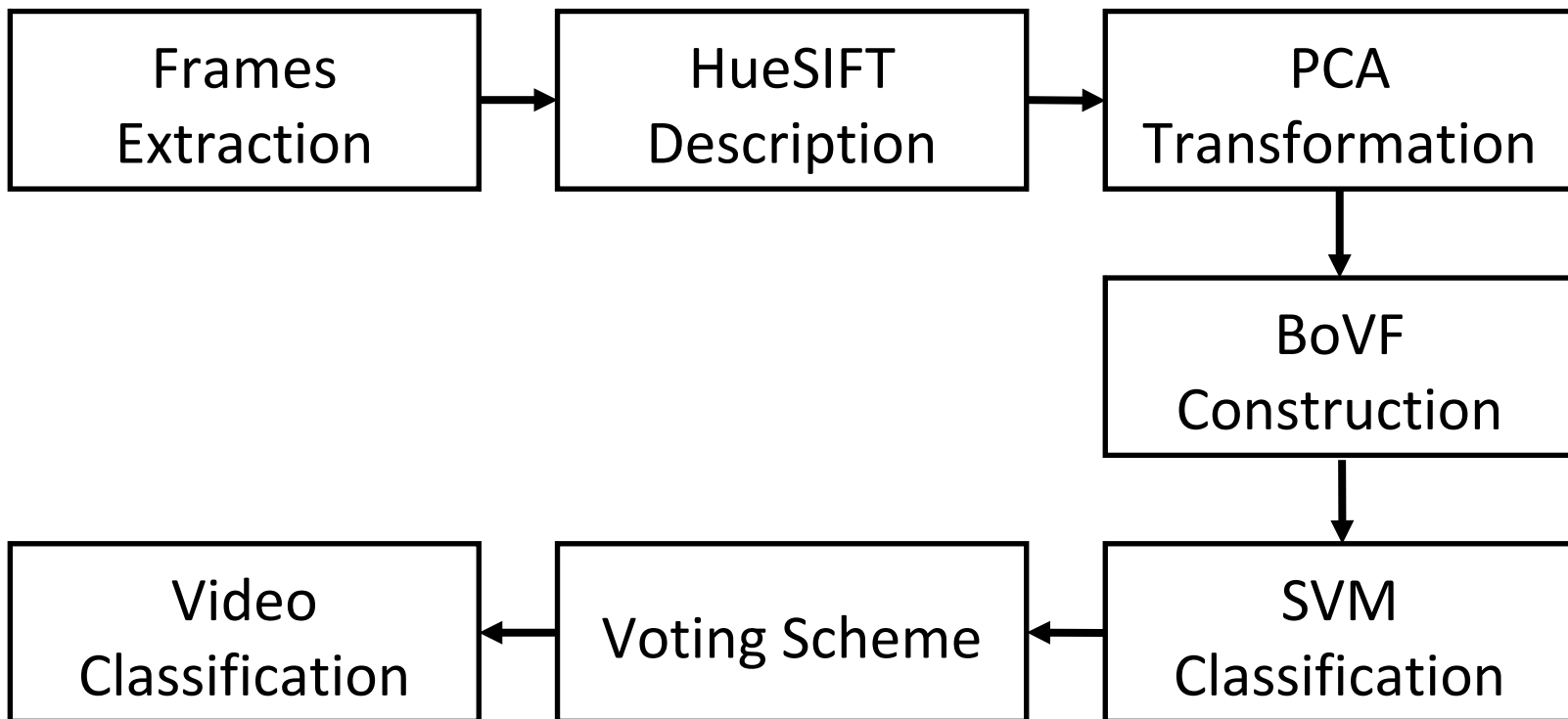


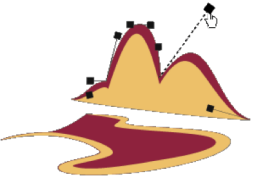
5) Histogram computation



# Detecting Nudity from Videos

## Our approach

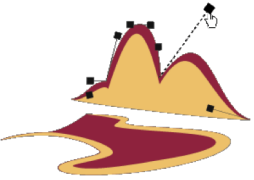




# Experimental Results (1/4)

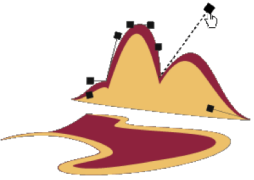
- Database
  - 179 segments
  - Nude sequences
    - From 43 to 308 frames long
  - Non-nude sequences
    - From 50 to 278 frames long
  - <http://www.npdi.dcc.ufmg.br/nudeDetection>





# Experimental Results (2/4)

- Experimental Setup
  - Frames selection:
  - samples rates
    - 1/15, 1/30
  - BoVF creation
    - 10,000 random HueSIFT points
  - Vocabulary size: 60, 120 and 180
  - Linear SVM classifier
    - $10^{-5} \leq C \leq 10^5$
    - 30 5-folds cross-validation runs



# Experimental Results (3/4)

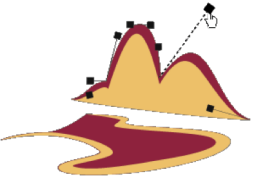
Table I: Comparing recognition rates for keyframe and voting based classification.

Voc. Size	Keyframe (%)	Voting (%)	Increase
60	$76.4 \pm 0.2$	$77.1 \pm 0.4$	0.7
120	$80.2 \pm 0.3$	$80.9 \pm 0.4$	0.7
180	$83.9 \pm 0.2$	$88.4 \pm 0.6$	4.5

(a) 1/30 frames

Voc. Size	Keyframe (%)	Voting (%)	Increase
60	$79.1 \pm 0.1$	$80.5 \pm 0.4$	1.4
120	$83.7 \pm 0.2$	$87.3 \pm 0.4$	3.6
180	$85.9 \pm 0.1$	$93.2 \pm 0.4$	7.3

(b) 1/15 frames



# Experimental Results (4/4)

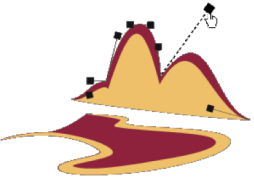
Table II: False-negative rates for keyframe and voting based classification.

Voc. Size	Keyframe (%)	Voting (%)	Decrease
60	$12.2 \pm 0.2$	$10.4 \pm 0.3$	1.8
120	$11.0 \pm 0.2$	$9.1 \pm 0.2$	1.9
180	$8.0 \pm 0.2$	$4.2 \pm 0.3$	3.3

*(a) 1/30 frames*

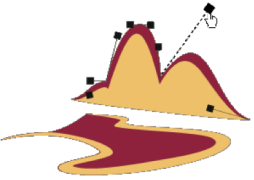
Voc. Size	Keyframe (%)	Voting (%)	Decrease
60	$10.7 \pm 0.1$	$10.7 \pm 0.3$	0.0
120	$10.0 \pm 0.1$	$8.5 \pm 0.2$	1.5
180	$7.5 \pm 0.1$	$4.2 \pm 0.2$	3.3

*(b) 1/15 frames*



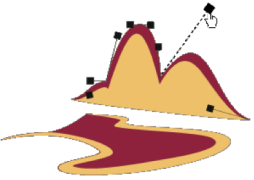
# Conclusion (1/2)

- The FIRST usage of BoVF for nude detection in VIDEOS.
- A voting scheme to extend the technique for videos
- A test database:
  - Collected
  - Segmented
  - Annotated
  - made available



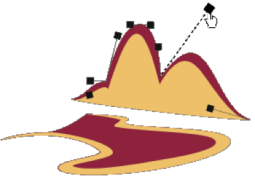
# Conclusion (2/2)

- 93.2% of correct classification
- Identified misclassification causes:
  - Background colors near to skin tones
  - Presence of large skin areas
  - Illumination variations

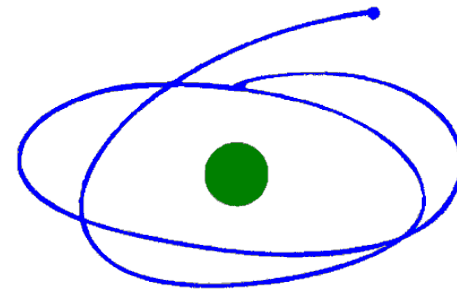


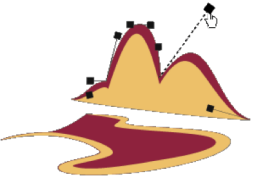
# Future Work

- To validate the proposed scheme using:
  - A large database
  - Low-resolution videos
- To study the vocabulary formation process in BoVF
- To modify the method to distinguish among more than two classes



# Acknowledgements





Thanks you for your attention!!!  
Questions? Ideas?