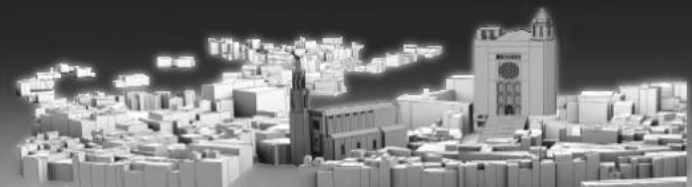


# EG2013 Tutorial on VIDEO VISUALIZATION

## 3. The Taxonomy of Video Visualization

Rita Borgo

Swansea University



# Taxonomy of Reference



## Classification by Output DataTypes

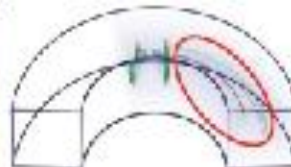
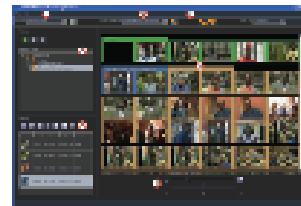
### Video Visualization

Another video or an Animation

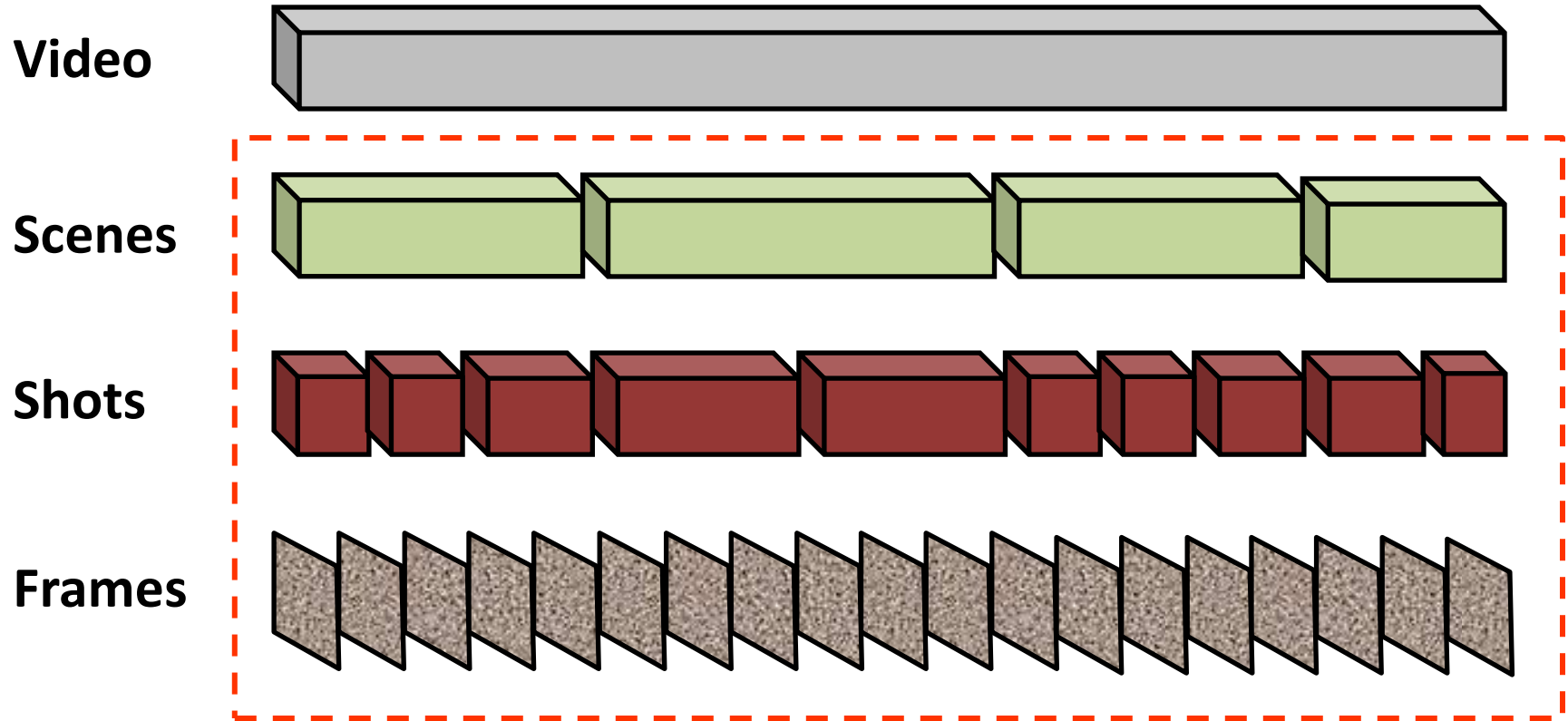
A large collection of images

A single composite image

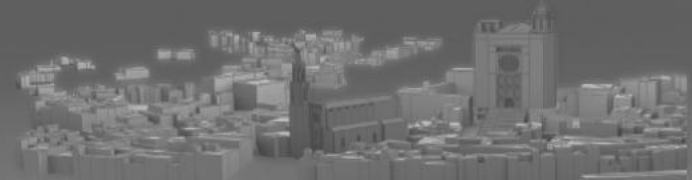
Additional information and actions



# Structure of a Video



# Keyframe Selection

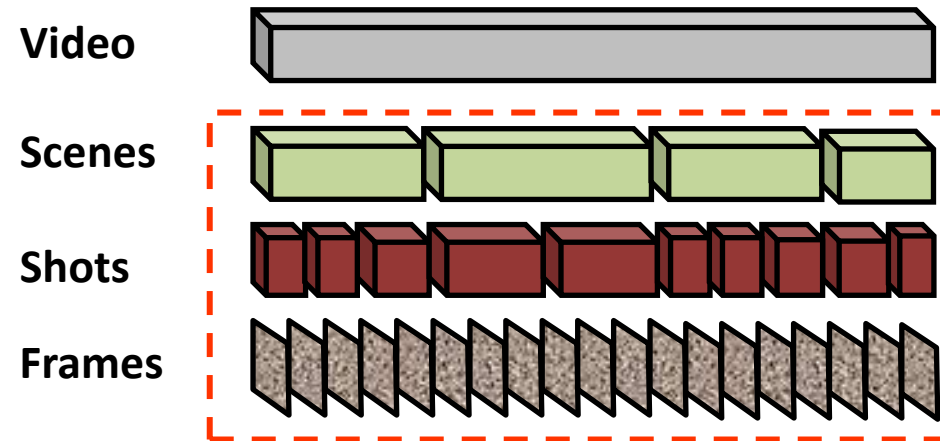


- Keyframes selection:  
choice of images  
representative of a video  
(shots or sequences)

- First Step in image-based  
video visualization

- Strategy needed:

- Max number of Frames  
(cond: limited resources)
- Error Rate  
(cond: optimality criterion [Truong et al. 07])



**The two  
parameters  
are usually  
correlated**

# Optimality Criteria



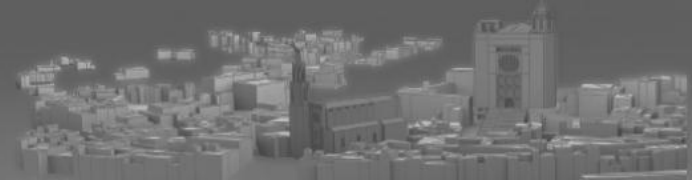
## ■ Uniform selection:

- Missing short key scenes;
- Depiction of long uninteresting scenes.

## ■ Content based selection:

- *Truong et Venkatesh [2007]*
  - Sufficient content change: keyframes mutually represent different visual content;
  - Maximum frame coverage: keyframes represent a maximum number of frames that are not keyframes;
  - Feature space analysis: keyframes are representative points of a cluster in feature space;
  - Minimum correlation: keyframes feature a minimum amount of correlation between each other;
  - “Interesting” events: keyframes have high information (semantic) content.

# Outline



## Video Visualization

Another video or an Animation

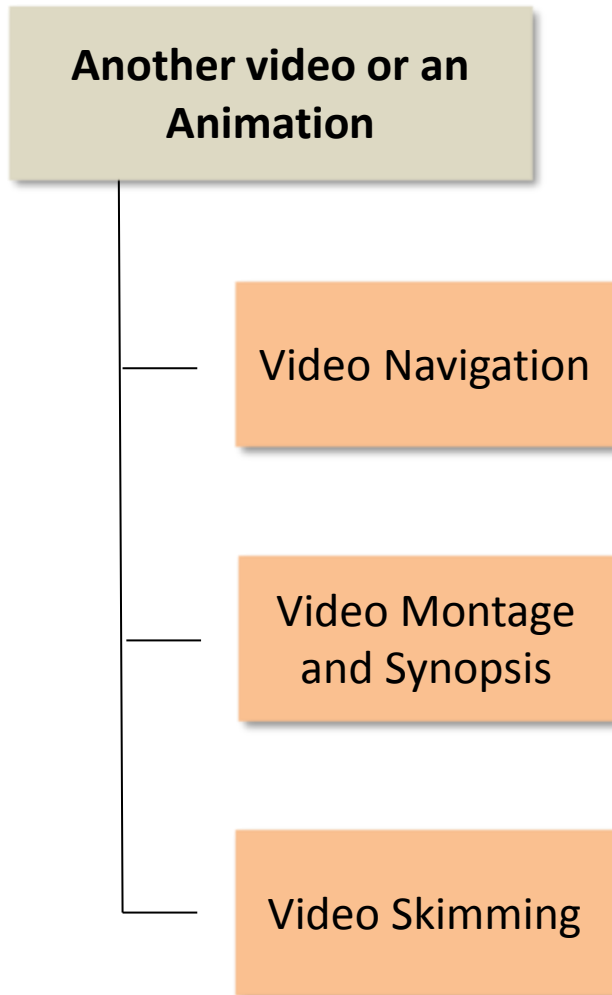


A large collection of images

A single composite image

Additional information and actions

# Another Video or an Animation

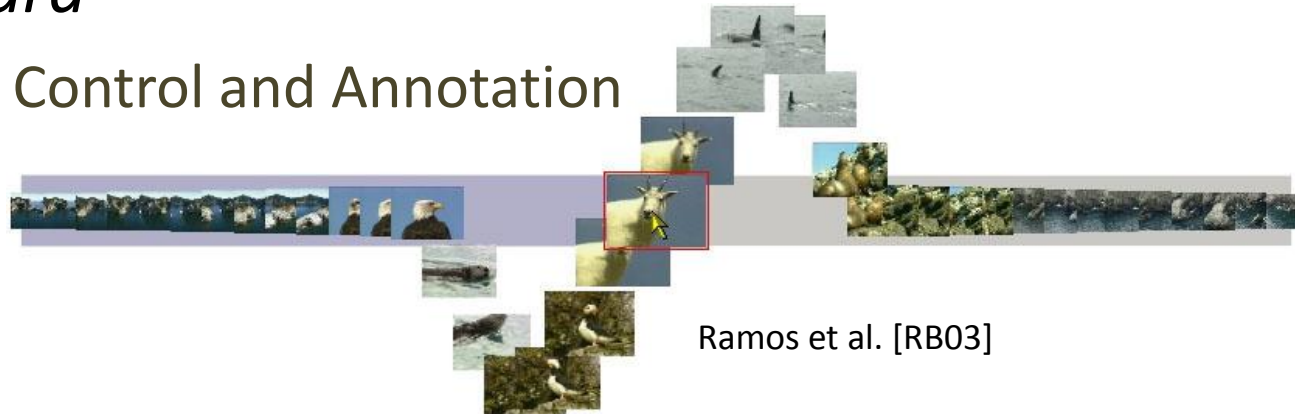


- Watch a video without leaving the video output domain:
  - *Video Browsing, Manipulation and Annotation*
  - *Video Clips*
  - *Video Compression and Abstraction*

# Another Video or an Animation I

## ■ Video Navigation *Play, Pause, Fast Forward/Backward*

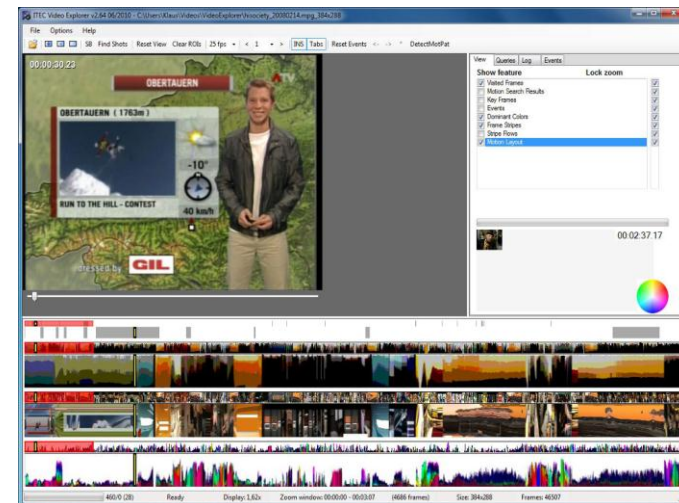
- *G. Ramos [RB03]: Control and Annotation of Videos*



Ramos et al. [RB03]

- *K. Schoeffman [SB09]: Video Explorer*

- “A Tool for Navigation and Searching within a Single Video based on Fast Content Analysis”, ACM Multimedia Systems 2010.
- “Facilitating Interactive Search and Navigation in Videos”, ACM Multimedia.



Schoeffman et al. [SB09]



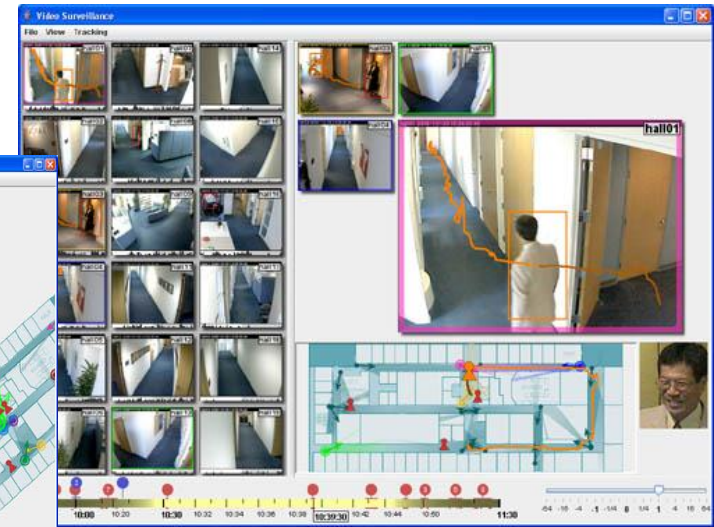
# Another Video or an Animation II

## ■ Video Navigation with Tracking:

- *D. Kimber et al. [KDG\*07]:*  
Dots surveillance system

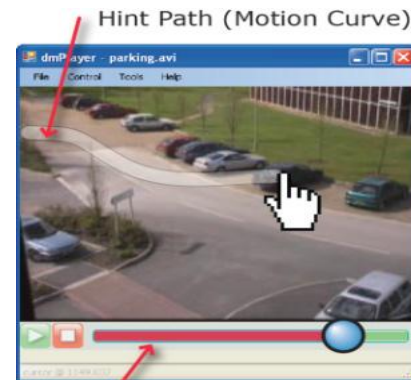


Kimber et al. [KDG\*07]



Kimber et al. "DOT Surveillance System"

- *P. Dragicevic et al. [DRB\*08]:*

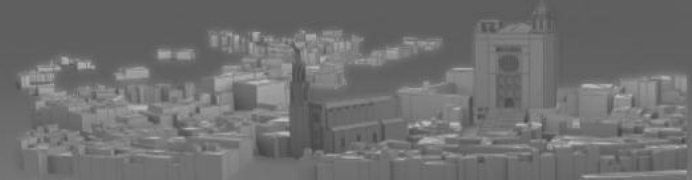


Moment when  
the car parks



Dragicevic et al. [DRB\*08]

# Another Video or an Animation III



## ■ Video Montage and Synopsis:

- Montage: *H. Kang et al.* [KCMT06]

- Loose spatial context
- Do not preserve space-time coherence



- Synopsis: *Rav-Acha et al.* [RAPP06;PRAGP07;PRAP08]

- Preserve spatial context
- Do not preserve space-time coherence



Rav-Acha et al. [Rapp06]

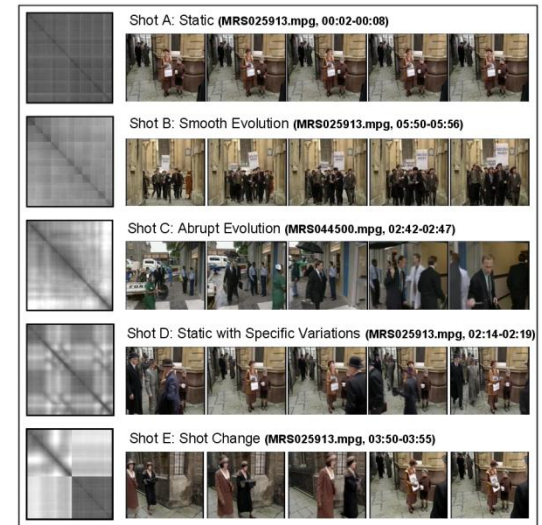


Pritch et al. [PRAP08]

# Another Video or an Animation IV

## ■ Video Skimming:

- Requires high-level content analysis  
*Peker et al.* [PD04], *Valdes et al.* [VM07], *Falchuk et al.* [FWEV11]
- *Truong et al.* [TV07] five step process:
  - Segmentation
  - Selection
  - Shortening
  - Multimodal Integration
  - Assembly

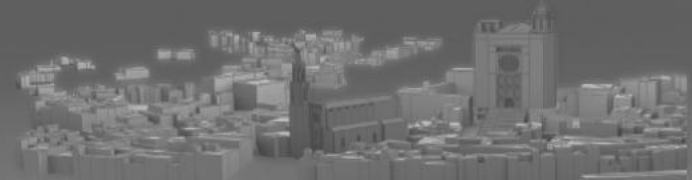


Valdes et al. [VM07]



Falchuk et al. [FWEV11]

# Outline



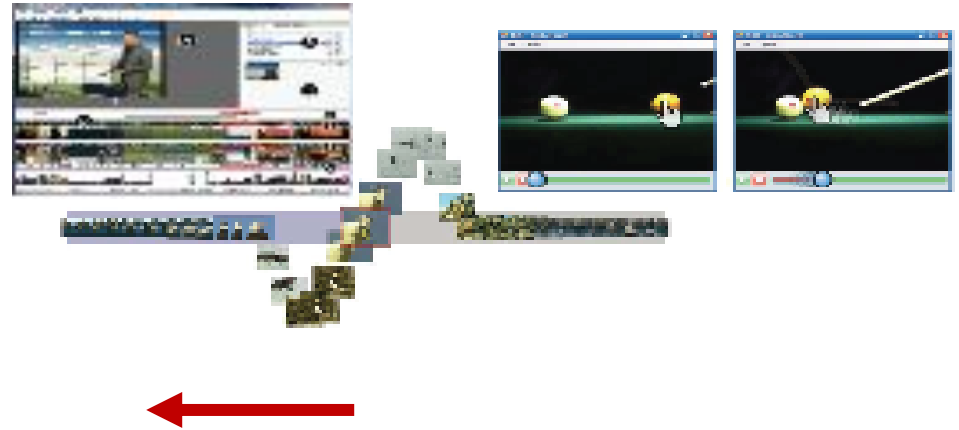
## Video Visualization

Another video or an Animation

A large collection of images

A single composite image

Additional information and actions



# A large collection of images

## ■ Storyboard:

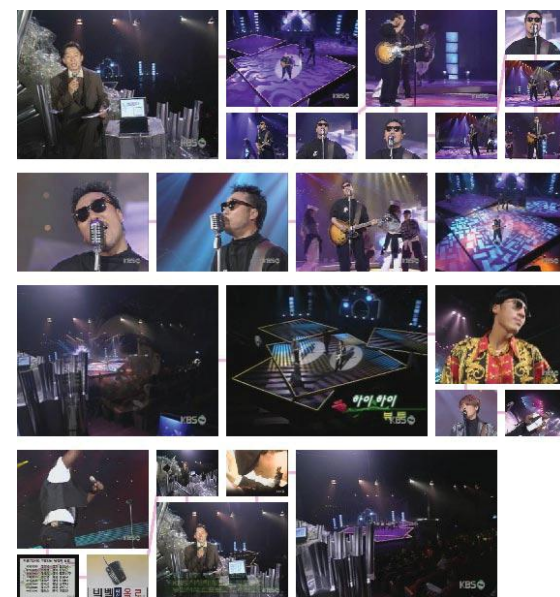
- Uniform *Bailer et al.* [BT07];
- Hierarchical *Sull et al.* [LSB\*00, SKK\*01];
- Hierarchical+Semantic *Yeung et al.* [YY97], *Uchihashi et al.* [UFG99]



Bailer et al. [BT07]



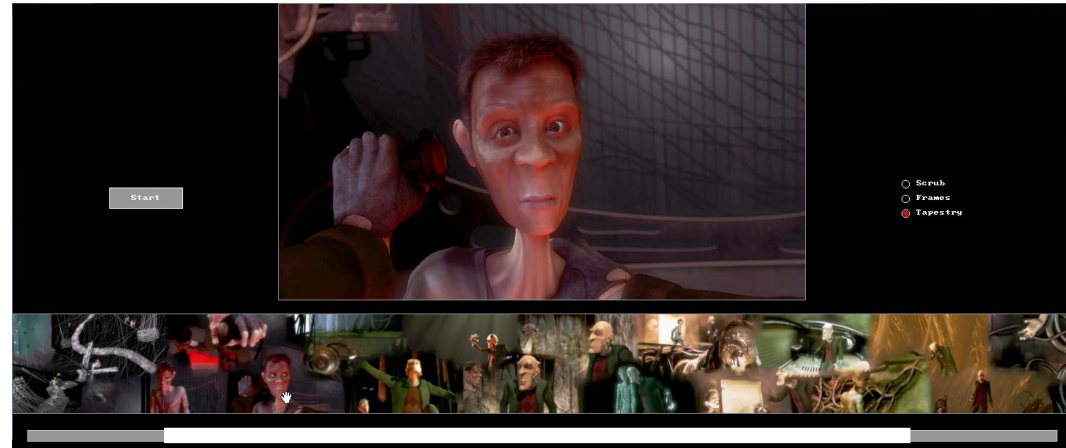
Yeung et al. [YY97]



Uchihashi et al. [UFG99]

# A large collection of images

- Tapestries *Barnes et al.* [BGSF10]



# Outline



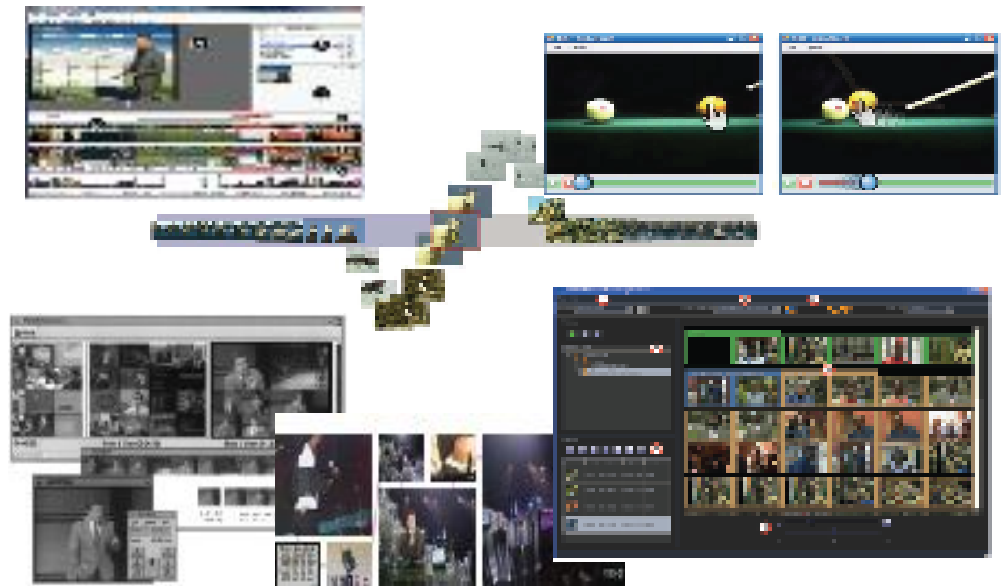
## Video Visualization

Another video or an Animation

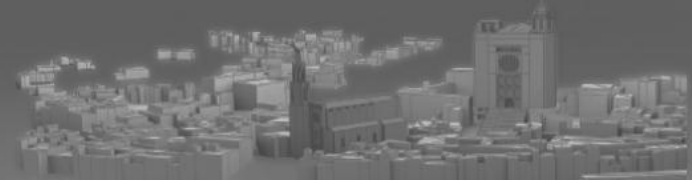
A large collection of images

A single composite image

Additional information and actions



# A single composite image



## ■ Alter content of individual keyframes:

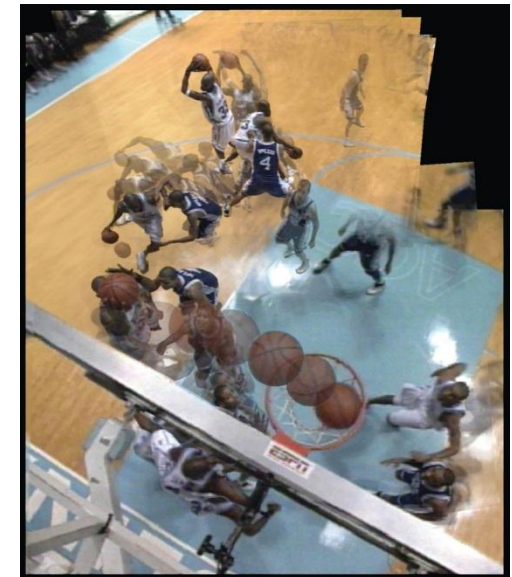
- Salient Stills *Teodosio et al.* [TB05]

- Stained Glass  
*Chiu et al.* [CGL04]

- Collage *Mei et al.* [MYYH08]



Chiu et al. [CGL04]



Teodosio et al. [TB05]



(a) Video keyframes



(b) BS-Video Collage



(c) FS-Video Collage

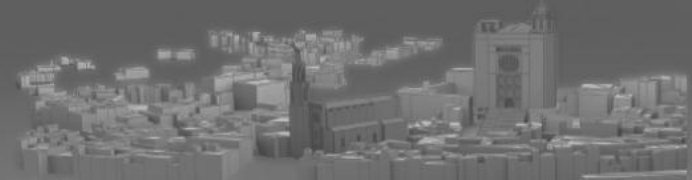


FreeForms (Mei et al. [MYYH08])

Mei et al. [MYYH08]

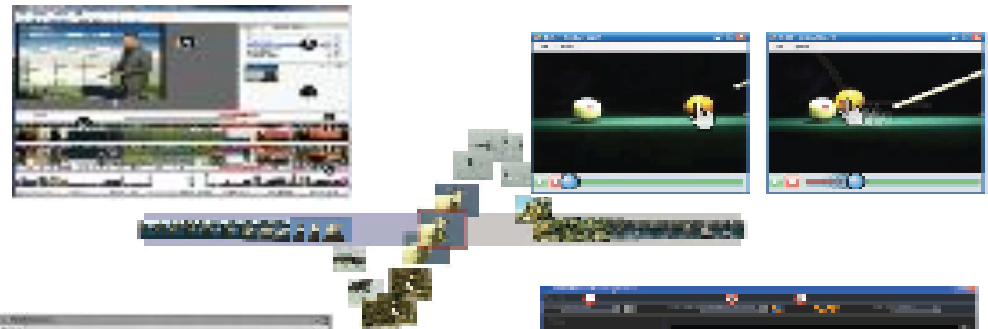


# Outline

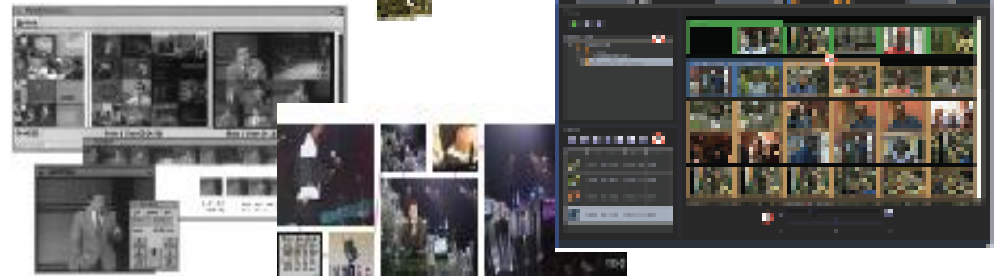


## Video Visualization

Another video or an Animation



A large collection of images



A single composite image

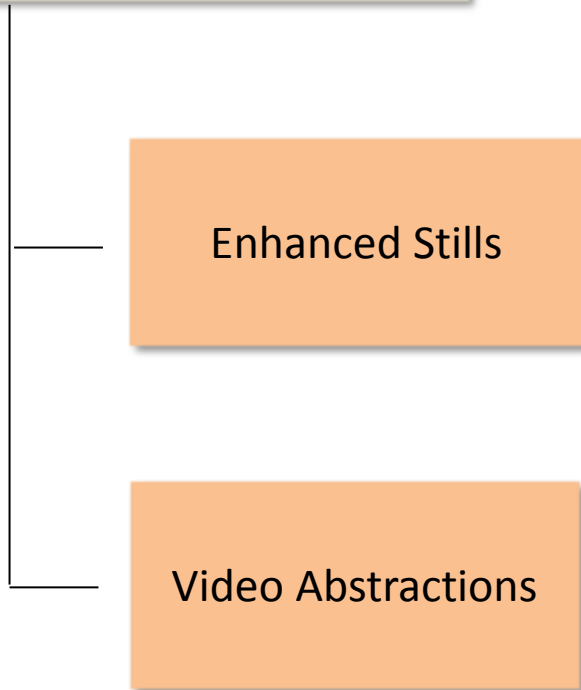


Additional information and actions



# Additional information and action

## Additional information and actions



➤ Add information to the selected keyframes:

➤ Schematic Storyboarding

➤ Space-Time Volume Summarization

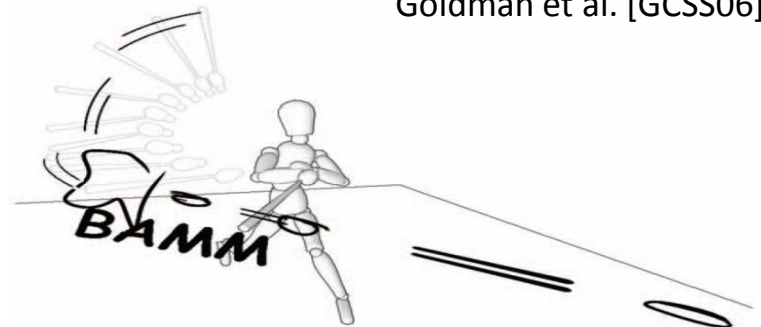
# Additional information and action I

## ■ Enhanced Stills:

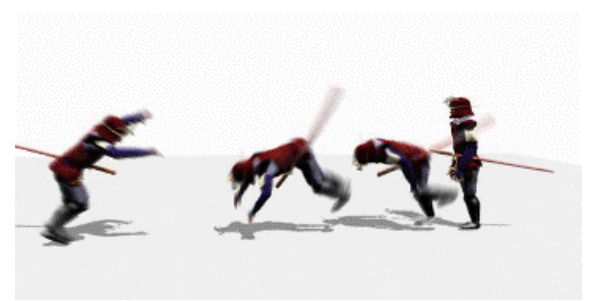
- Storyboards *Goldman et al.* [GCSS06]
- Dynamic Glyphs *Nienhaus et al.* [ND05]
- Graph-Based *Assa et al.* [ACCO05]



Goldman et al. [GCSS06]



Nienhaus et al. [ND05]

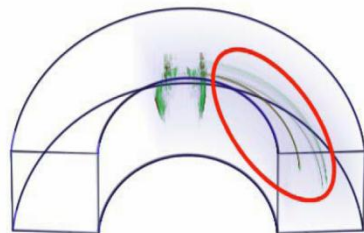
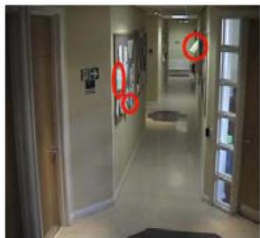
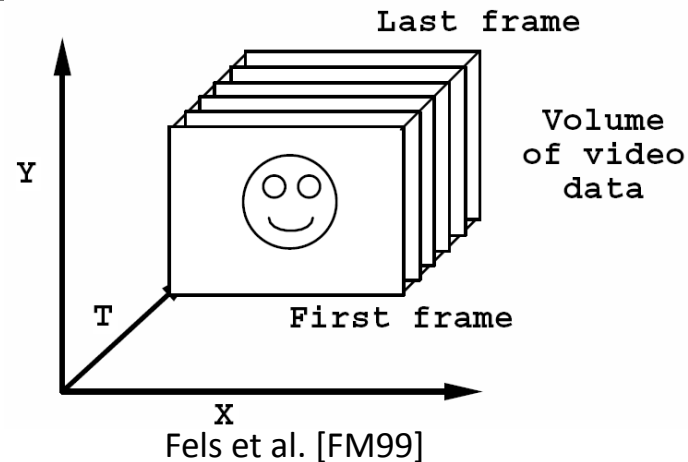


Assa et al. [ACCO05]

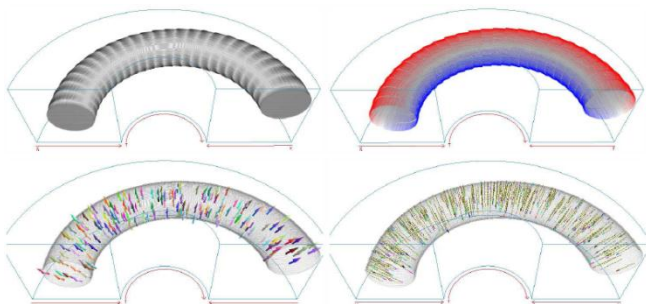
# Additional information and action II

## ■ Video Abstractions:

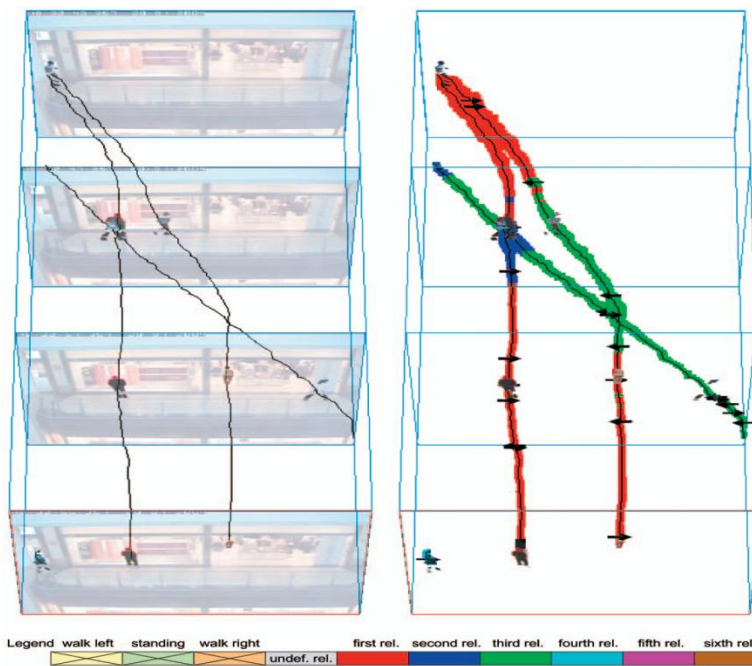
- Main Abstraction: Space-Time Volume *Fels et al. [FM99]*
- Visual Signatures *Daniel et al. [DC03], Chen et al. [CBH\*06]*



Daniel et al. [DC03]



Chen et al. [CBH\*06]



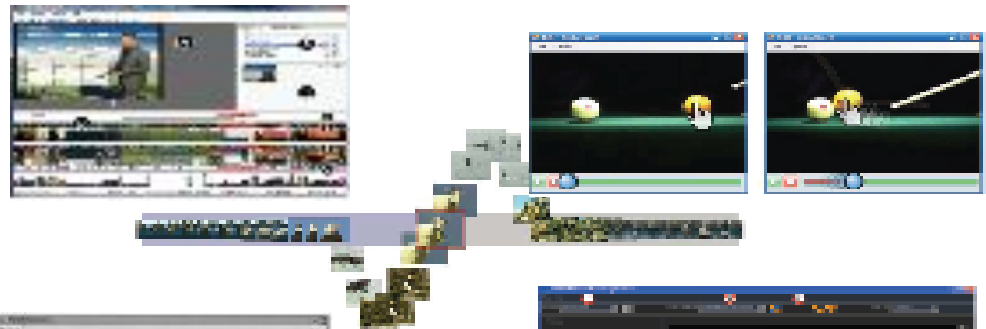
Botchen et al. [BBS\*08]

# Back to the Taxonomy

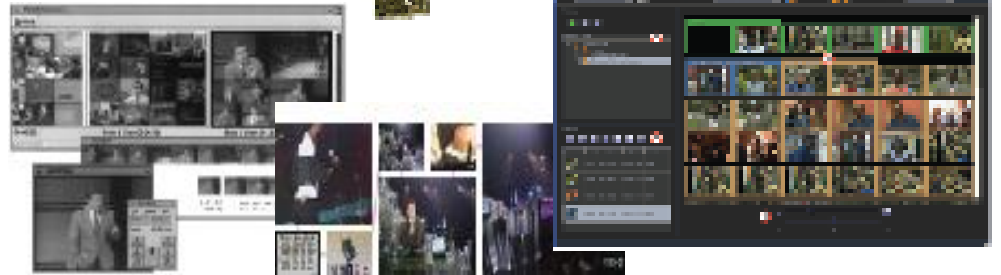


## Video Visualization

Another video or an Animation



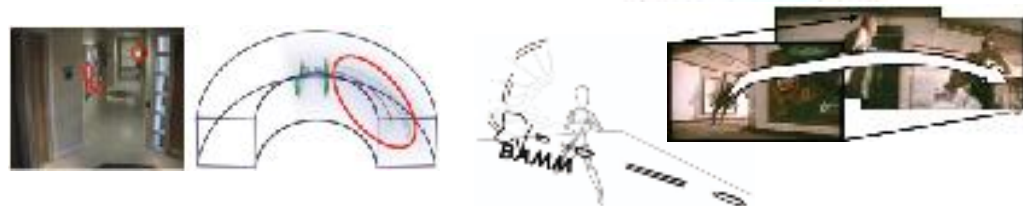
A large collection of images



A single composite image



Additional information and actions



# The Full Taxonomy

## Classification by Goals

### Classification by Sub-goals

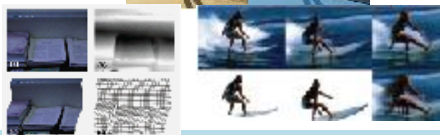
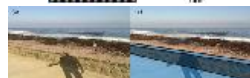
#### Video Based Graphics

Artistic Presentation

Compositing

Editing / Retargeting

Video-based Modeling



### Classification by Output DataTypes

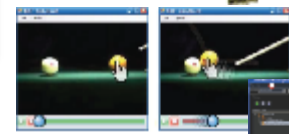
#### Video Visualization

Another video or an Animation

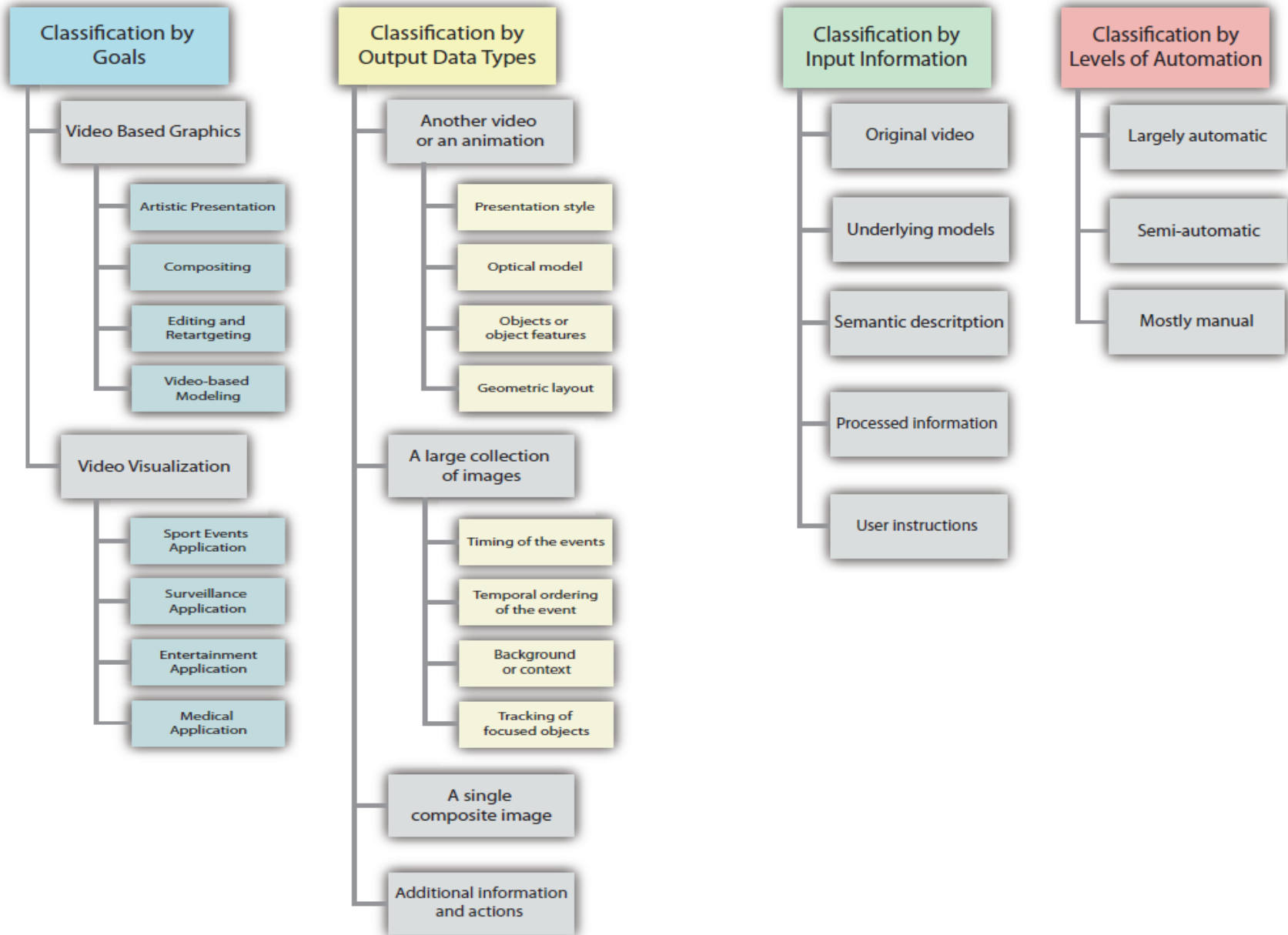
A large collection of images

A single composite image

Additional information and actions



# Proposed Taxonomy



# Challenges and Opportunities



- **Semantics: input, coding and output**
  - difficult to automate
  - interaction
- **Large volumes of video data**
  - availability and applications
  - may not always scale
- **Stereo video streams**
- **Video-based graphics**
  - artistic goal shifting
  - object, scene, action and event capturing and remodelling
- **Video visualization**
  - demand for gaining information, cost-effectively
- **Video processing**
  - new advances → better underlying technologies
  - shortcomings → opportunities for bridging the gaps



# Thank you



- All detailed citations can be found at

***“State of the art report on video-based graphics and video***

***visualization”***, R. Borgo., M. Chen, B. Daubney, E. Grundy, H. Jaenicke, G.

Heidemann, B. Hoferlin, M. Hoferlin, D. Weiskopf and X. Xie, *Computer Graphics Forum*, 31(8):2450-2477, 2012.

- Questions?