Efficient Video Coding in H.264/AVC by using Audio-Visual Information

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Introduction

- **Objective of video coding**
  - Better quality with smaller number of bits

- **How to achieve better video coding efficiency?**
  - Using statistics of signal
  - Using human visual system's characteristics: Focus of attention
    - Only small region around fixation point is captured at high spatial resolution.

Unattended region

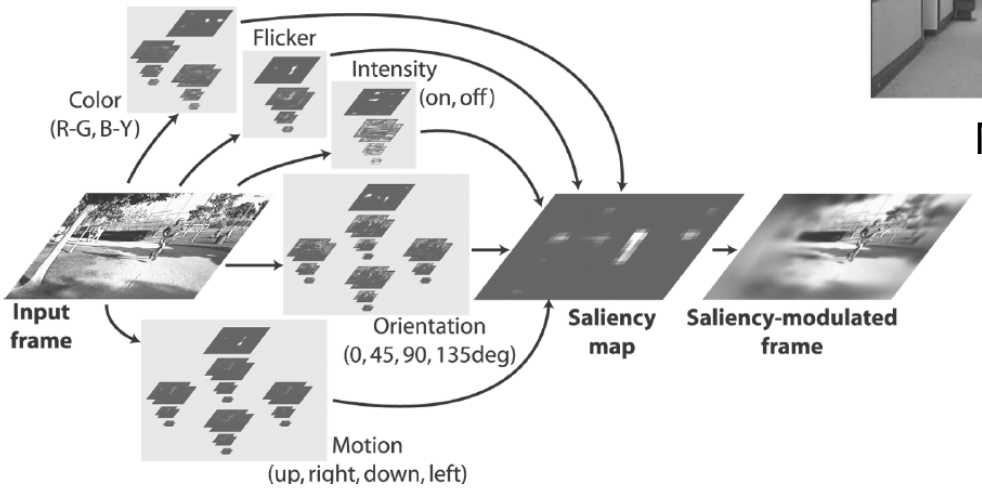
→ more compression

Attended region

→ less compression

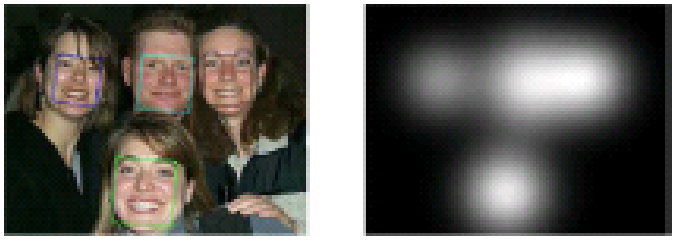
Introduction

- **Which region draws attention?**



Conspicuity-based (Itti, 2004)

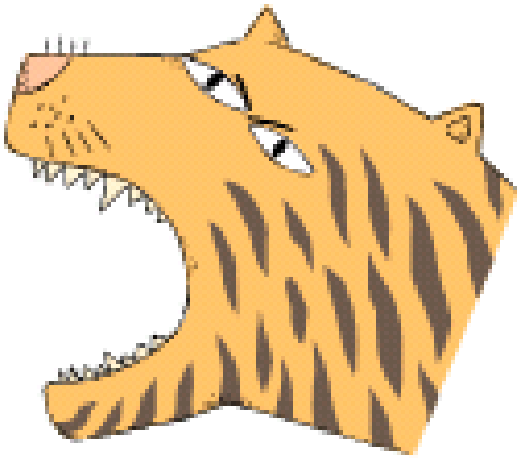
Moving object-based (Cavallaro, 2005)



Face-based (Boccignone, 2008)

No consideration of cross-modal (audio-visual) interaction!

Audio-Visual Focus of Attention

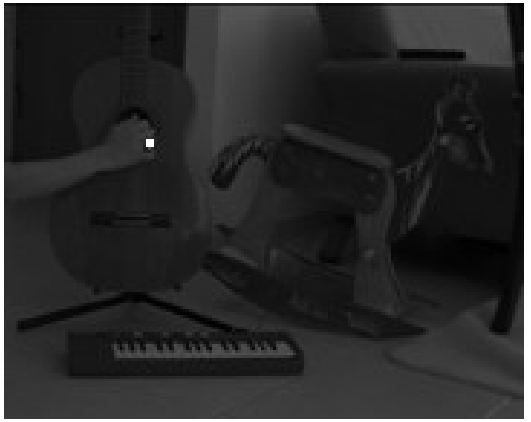


- Abrupt sound draws visual attention to sound source location. (Spence, 1997)
- Attending to auditory stimuli at given location enhances processing of visual stimuli at same location. (Spence, 1996)

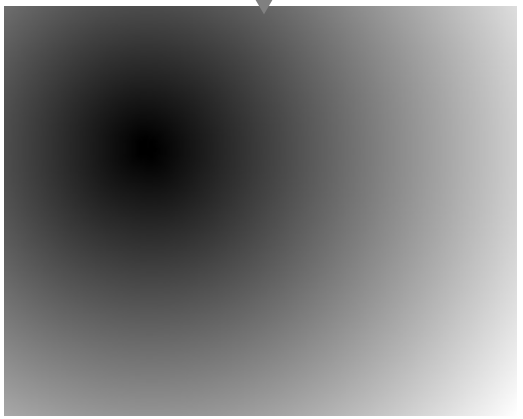
➔ We define sound-emitting region as attended region.

Overall Procedure

Original frame



Source localization



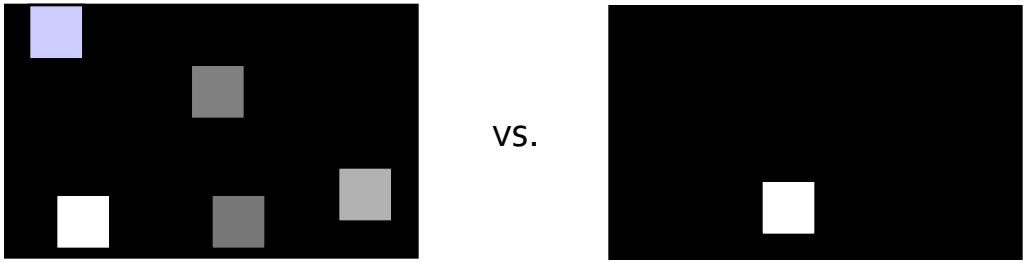
Priority map

Slice grouping

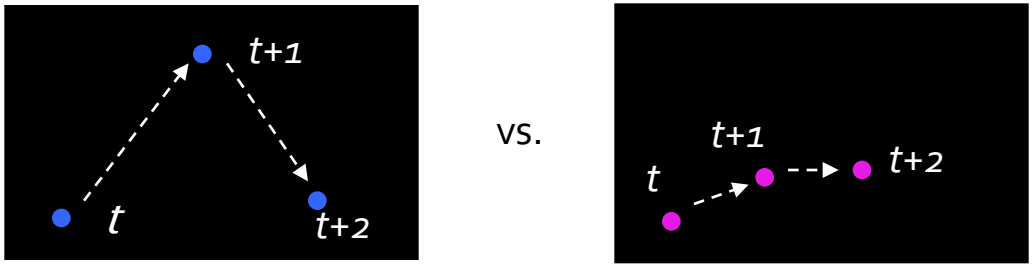
H.264/AVC coding with flexible macroblock ordering (FMO)

Audio-Visual Source Localization

- **To identify spatial location of sound source in scene**
- **Approach**
  - Canonical correlation analysis
    - To find projection vectors of two data for maximizing correlation
  - Sparsity principle



  - Spatio-temporal consistency

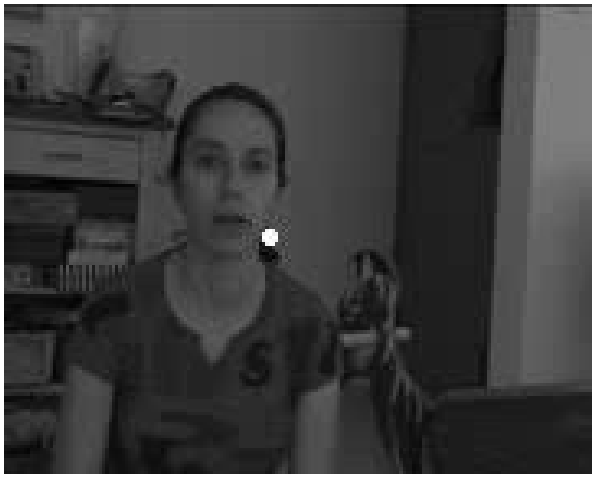


Audio-Visual Source Localization

- **Constraint optimization → linear programming**

- **Advantages**
  - Applicability to normal video with mono audio channel
  - No assumption on sound source
  - No training required

- **Example**



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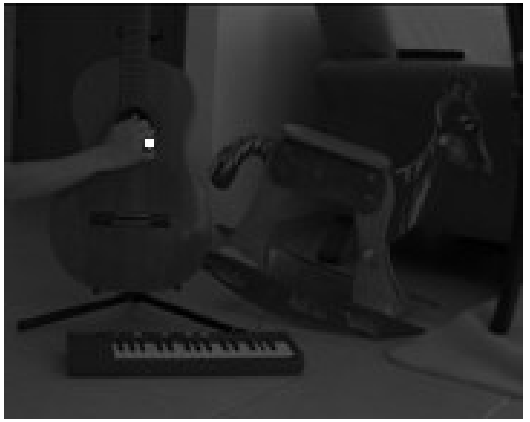
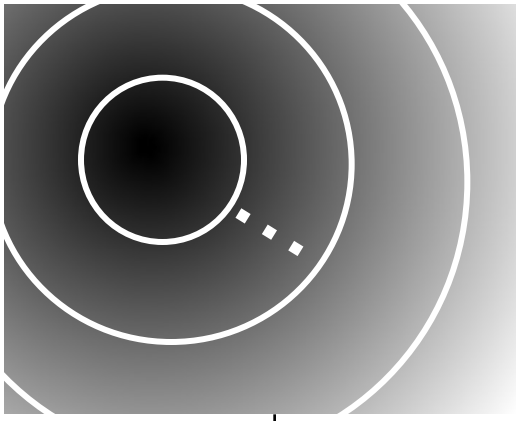
"Video coding based on audio-visual attention,"
ICME'09

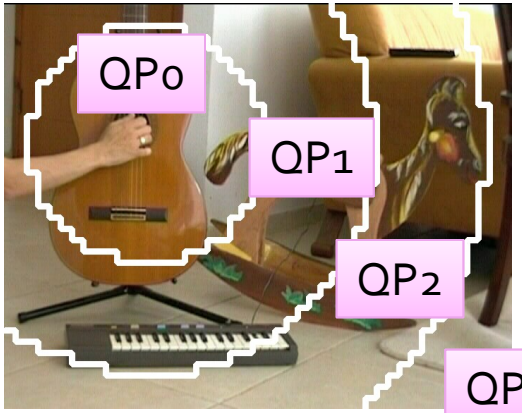
Video Coding

Localization result



Priority map





$QP_1=QP_0+\Delta QP$

$QP_2=QP_1+\Delta QP$

$QP_3=QP_2+\Delta QP$

...

Slice grouping

H.264/AVC coding with FMO (Type 6)

* QP=quantization parameter

Experiments

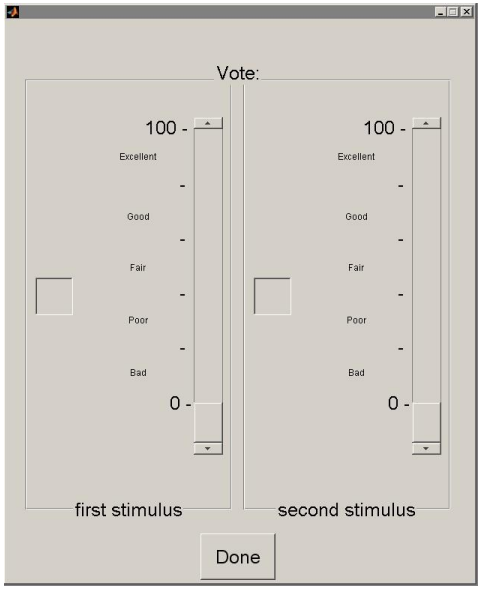
- **2 test sequences including multiple moving objects in scene**

- **Audio-visual source localization**
  - Visual features: differential grayscale pixel value
  - Audio features: differential frame energy

- **H.264/AVC coding: JM reference software**
  - Constant QP mode
  - Rate control (adaptive QP) mode
  - Proposed method (FMO enabled)

Experiments

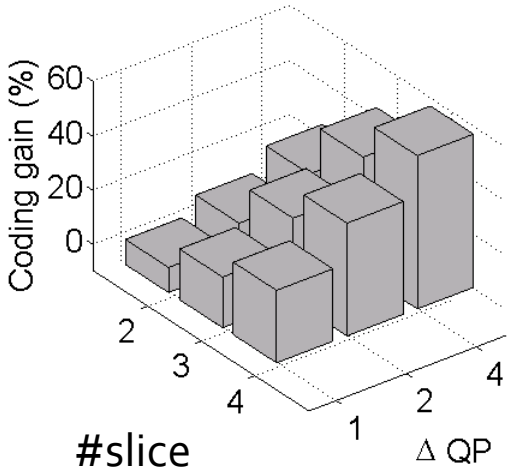
- **Subjective test**
  - Is quality degradation acceptable?
  - ITU-R BT.500-11
  - Double stimulus continuous quality scale (DSCQS)



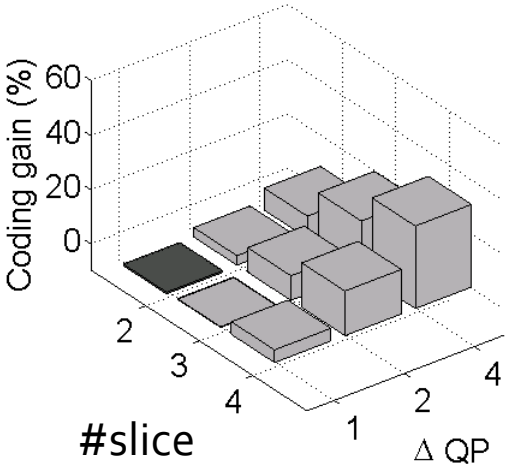
Result

- **Coding gain by proposed method over constant QP mode**

QP0=22



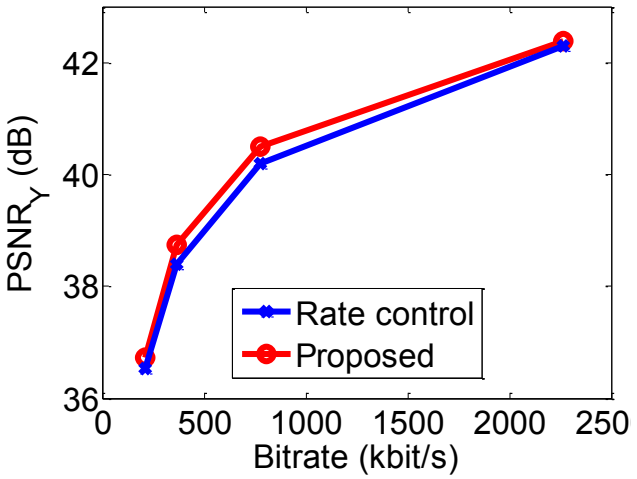
QP0=30



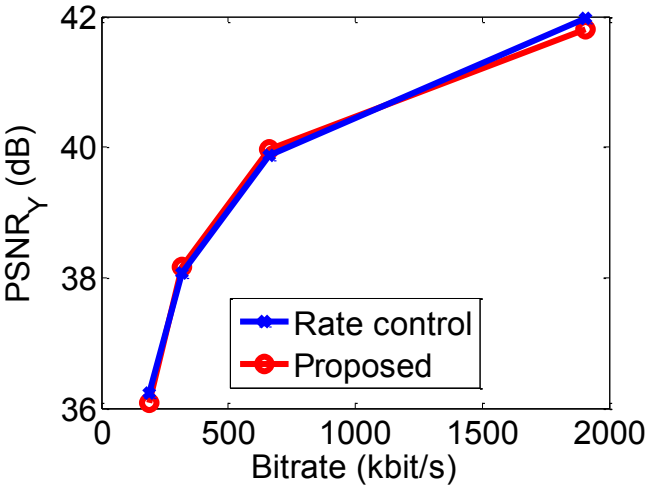
Result

- **Rate-distortion curves**
  - Proposed method (#slice=2) vs. rate control

ΔQP=1

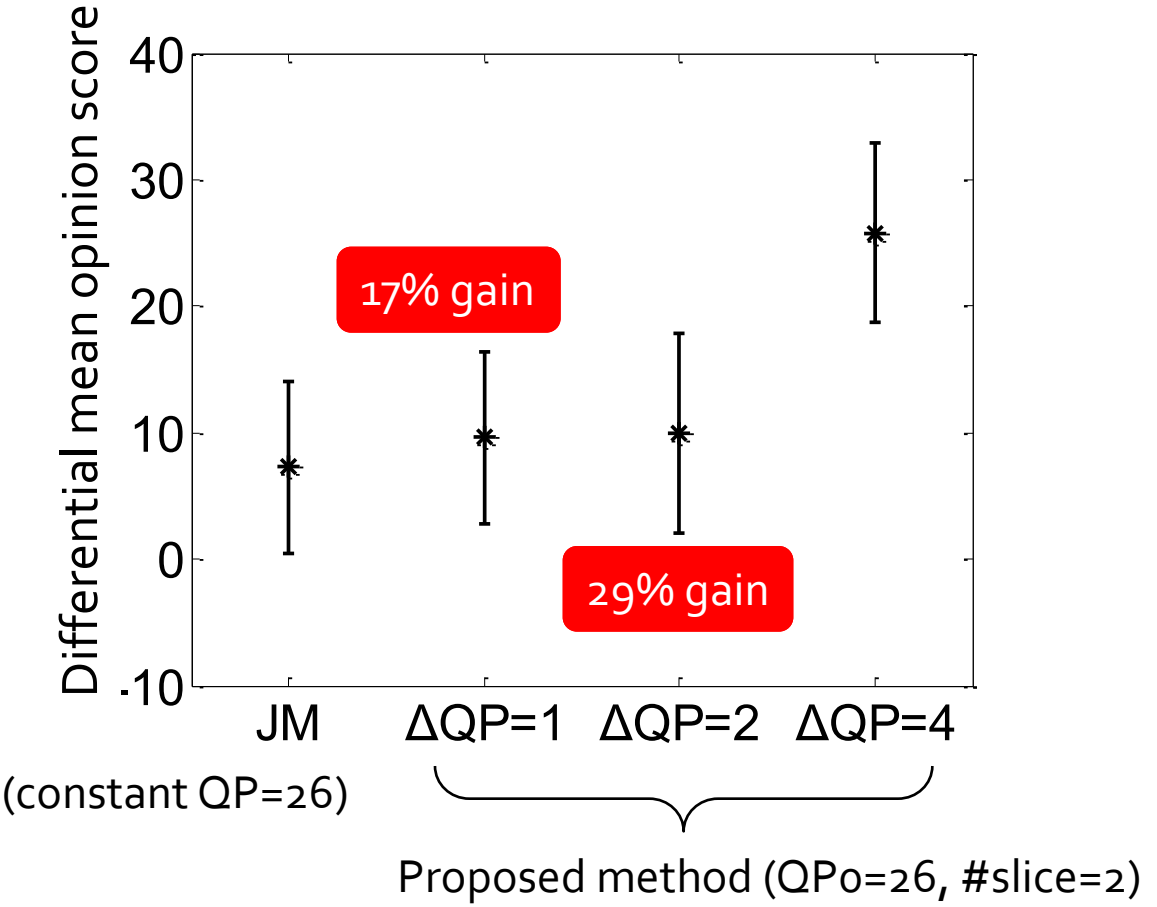


ΔQP=4



Result

- **Subjective quality comparison**



Conclusion & Discussion

- **Audio-visual focus of attention (AV FoA) influences perceived quality. And, it can be used for efficient video coding by H.264/AVC.**

- **Discarding information outside focus of attention does not degrade perceived quality significantly.**

- **AV FoA does not explain everything. It should be combined with other attention mechanisms.**

Questions/comments are welcome!

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